Preliminary Feasibility Study **November 2010**

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Citizens Energy | Imperial Irrigation District | APS | Starwood Energy Group | 21st Century Transmission | Energy Investors Funds

FOREWORD

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EXECUTIVE SUMMARY

Sonoran-Mojave Renewable Transmission (SMRT) Project Purpose

The primary purpose of the SMRT Project concept is to take a regional look at the feasibility of: (i) providing transmission capacity for renewable resources, (ii) providing wholesale and retail markets in Arizona and California access to those renewable resources and (iii) providing a more robust transmission grid in the southwestern United States. The utilities participating in the study have requests in their respective large generator interconnection queues from renewable resource developers and have indicated that, until transmission system upgrades are built, very little additional generation, including generation from renewable resources, can be added to the power grid in the Sonoran-Mojave areas.

The above described needs are part of a larger group of "study factors" that contributed to forming the SMRT Project Study, which include:

- *Significant interest in renewable resources and barriers to entry based on limited transmission*

  The interest in renewable resources is most clearly reflected in the renewable portfolio standards (RPS) that are currently being implemented, as well as those that are being considered as a major component of energy policy at both the national and state level. For example, California's 20 per cent RPS (20 per cent by 2010) has recently been increased to a very ambitious 33 per cent RPS (33 per cent by 2020). These ambitious goals, however, face significant transmission-based barriers to entry that are well understood by the SMRT Study Participants. With the utility participants' sizeable Large/Small Generator Interconnection (LGI/SGI) queues, the SMRT Study Participants are in a unique position to understand the barriers and limitations of the existing transmission systems in the Desert Southwest region.

- *Western's Transmission Infrastructure Program (TIP)*

  In 2009, Western initiated a public process that invited the public to make Western aware of potential transmission projects by submitting Statements of Interest (SOI) to its TIP. Western received numerous SOIs describing potential transmission projects in the Southwestern United States. After reviewing the SOIs and consulting with a number of entities, it appeared that many of the proposed projects had common and overlapping interests, goals, objectives, and benefits. Therefore, interested parties voluntarily worked to consolidate consideration of many proposals into the SMRT Project concept.

- *High solar intensity*

  The Southwestern United States is ideal for solar development as shown on the following map of Photovoltaic Solar Resources published by the National Renewable Energy Laboratory (NREL). [1]

[1] http://www.nrel.gov/gis/solar.html

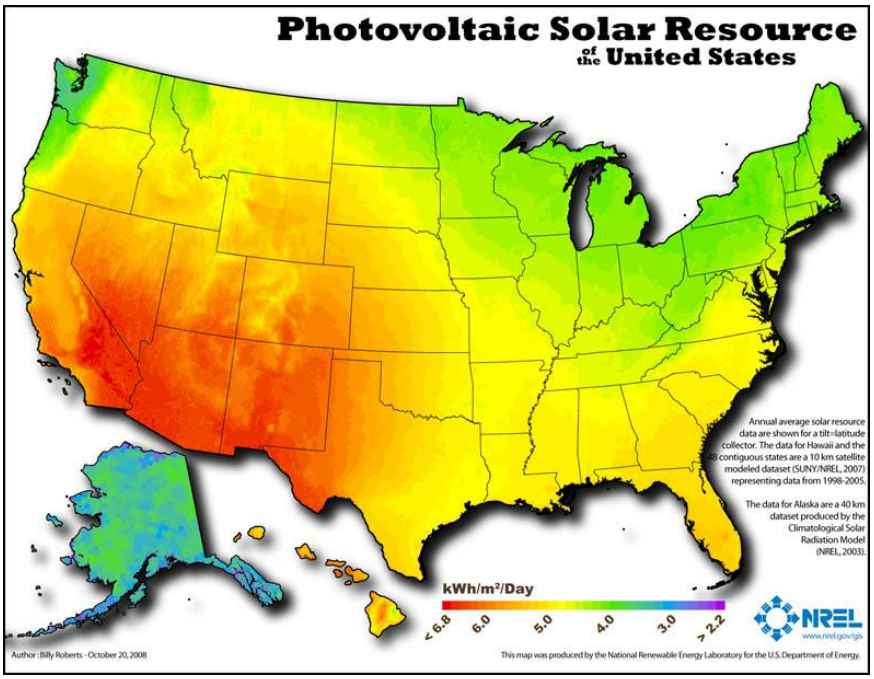

Figure 1 - PV Solar Resource Map

- *Identified Renewable Energy Zones (REZs)*

  The SMRT Study Participants established pre-defined REZs for purposes of this study by drawing upon past efforts such as the Western Governors Association's *Western Renewable Energy Zones - Phase 1* report published in June 2009. The identified REZs have no legal or regulatory status but serve as an indicator for renewable energy potential, especially when considered in conjunction with the potential for transmission additions and upgrades that offer market access as described below.

- *Access to significant markets*

  The study area for specific transmission additions and improvements was selected in large part based on the markets that could be accessed, including the California Independent System Operator (CAISO), Arizona and southern Nevada load centers.

- *Regional LGI/SGI Queues*

  The interconnection requests made of Western, Arizona Public Service (APS), Salt River Project (SRP), and Imperial Irrigation District (IID) indicate a significant need for additional transmission capability. For example, Western's, APS' and SRP's LGI/SGI queues[2] for the Desert Southwest Region include interconnection requests for renewable generation totaling more than 5,000 MW, 10,000 MW and 4,100 MW, respectively.

[2] Includes queues for SRP's solely owned transmission facilities and jointly owned facilities for which SRP is the Interconnection Administrator.

Nine public and private power firms/entities and the U.S. Department of Energy Solar Technologies Program voluntarily joined together to define and fund a preliminary feasibility study (Study) to determine the technical merits of this potential regional effort. As studied, the SMRT Project includes construction of new transmission lines and upgrades to the existing grid to help deliver renewable energy from remote sites in southeastern California, western Arizona, and southern Nevada to load centers across the Desert Southwest region.

Study Participants

Participants in the study include:

- Arizona Public Service Company (APS)
- Citizens Energy Corporation (Citizens)
- 21st Century Transmission (21st Century)
- Imperial Irrigation District (IID)
- Salt River Project (SRP)
- Solar Energy Technologies Program, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy (DOE)
- Starwood Energy Group Global, LLC (Starwood)
- Trans-Elect Development Company, LLC/Energy Investors Funds (Trans-Elect)
- Wellton-Mohawk Irrigation and Drainage District (WMIDD)
- Western Area Power Administration, Federal Power Marketing Administration, U.S. Department of Energy (Western)

Study Scope Highlights

The SMRT Study Participants formed an ad hoc study group (Study Group) that represents a diverse set of interests and expertise in developing renewable resources and new transmission capability. With this expertise, the Study Group was able to assume a very "hands-on" approach in formulating a study plan. The Study Group:

- Established the goals and objectives of the Study.
- Selected the transmission system elements comprising the SMRT Project.
- Agreed on the study approach.
- Selected the study area.
- Determined the configurations that would be evaluated.
- Provided all power flow cases.
- Determined the generation injection points (the Collector Injection Buses) within identified renewable energy zones.

The Study goal, as established by the Study Group, was to determine the system impacts associated with constructing new and upgraded transmission lines which would interconnect load centers with new renewable sources of generation. To accomplish this, the primary study objectives were set to:

1) Perform power system technical analyses to determine the simultaneous and non-simultaneous maximum generation injection capability in the pre-defined resource zones.
2) Determine effects on major transmission paths such as East of River (EOR) and West of

River (WOR).

3) From the results of 1 and 2 above, evaluate the viability of accomplishing the goal to interconnect load centers to regional markets.

Based upon the layout of the existing transmission system and the study factors listed above, especially the pre-defined renewable energy zones indicated in Figure 3, the Study Group identified the following major transmission system elements[3] for evaluation in the Preliminary Feasibility analysis:

- Element A - Hassayampa – N.Gila #2 500-kV Line
- Element B – Palo Verde – Blythe Area (Arizona portion of the Palo Verde – Devers #2 500-kV Line)
- Element C – Rebuild/Upgrade of the Western Colorado River Transmission System (Mead – N.Gila)
- Element D – Imperial Valley Renewable Transmission Project (N.Gila – Devers/Imperial Valley)
- Element S – Las Vegas to Los Angeles Double Circuit 500-kV

It is worth noting that several of these elements, including element A through element C, have previously been identified in Arizona utilities' 10-year plans; and all of the elements would involve participation by multiple entities and facilitate delivery of renewable energy to market. The technical analysis focused on evaluating Elements A through D with Element S being examined as a sensitivity analysis or an addition to the base analysis.

The proposed transmission elements were subsequently overlaid with the pre-defined renewable energy zones for the SMRT region to develop the basis for analyzing the ability to interconnect and deliver renewable resources throughout the Arizona, southern Nevada and southern California areas. Figure 3 depicts the overlay of the transmission elements and renewable energy zones considered in this Study.

[3] The Study Group identified the major transmission system as Elements A through D; and, Element S was studied as a sensitivity.

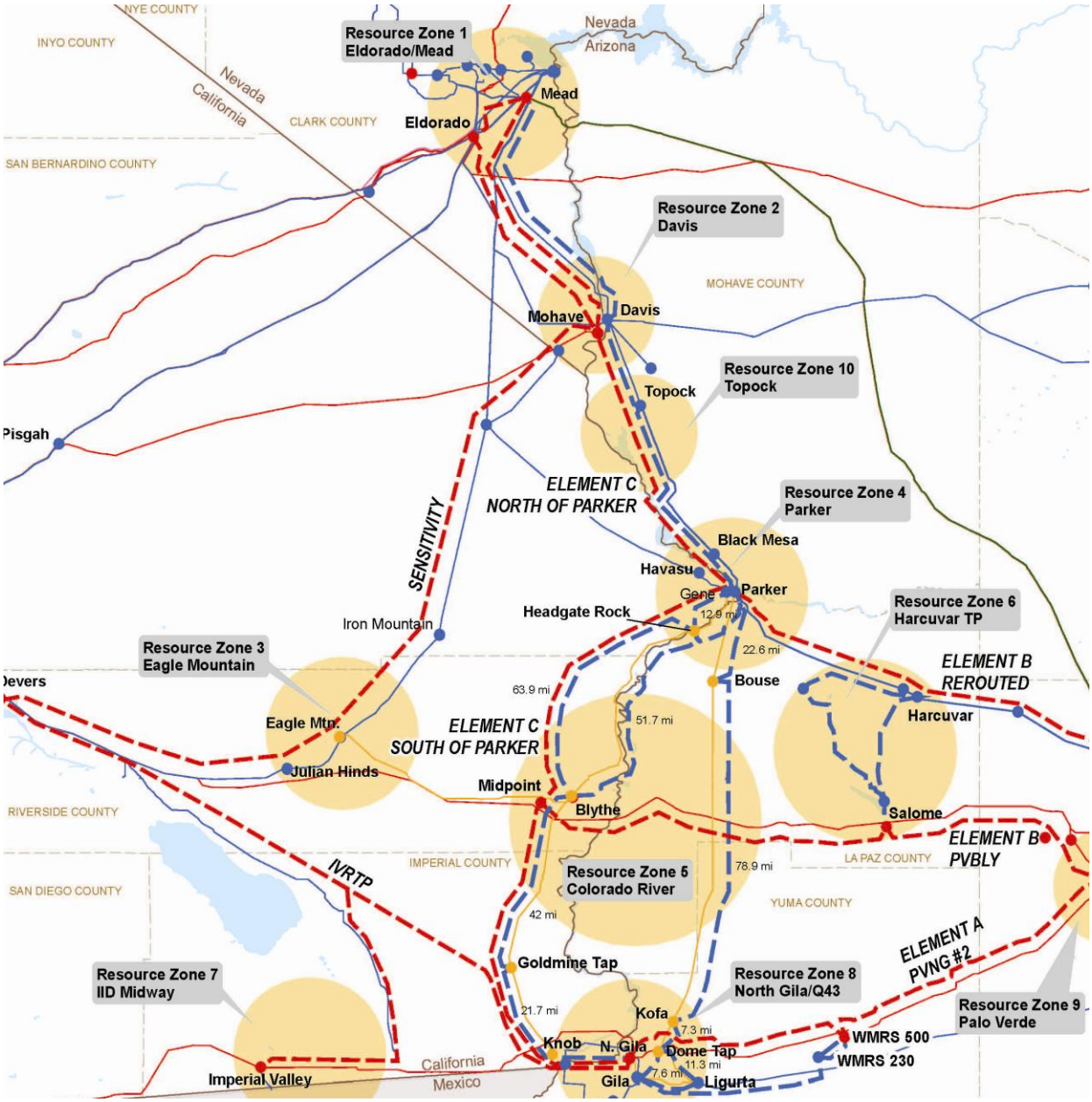

Figure 2 - Overlay of SMRT Transmission Elements and Renewable Energy Zones

Study Objectives

A major study objective was to determine maximum injection capability for renewable resources onto the SMRT transmission system as a whole. To accomplish this, various configurations (230-kV to 500-kV) of the major transmission elements were studied as shown in the following case matrix. The first 28 cases in this matrix are considered to be the Post SMRT Project cases; whereas, cases 29 through 38 are considered to be the sensitivity cases.

Case Matrix

Case #	Element A		Element B				Element C		Element D		Sensitivity
1	A1		B1				C3		D1		
2	A1		B1				C3			D2	
3	A1		B1					C4	D1		
4	A1		B1					C4		D2	
5	A1			B2			C3		D1		
6	A1			B2			C3			D2	
7	A1			B2				C4	D1		
8	A1			B2				C4		D2	
9	A1				B3		C3		D1		
10	A1				B3		C3			D2	
11	A1				B3			C4	D1		
12	A1				B3			C4		D2	
13	A1					B4	C3		D1		
14	A1					B4	C3			D2	
15	A1					B4		C4	D1		
16	A1					B4		C4		D2	
17		A2	B1				C3		D1		
18		A2	B1				C3			D2	
19		A2	B1					C4	D1		
20		A2	B1					C4		D2	
21		A2			B3		C3		D1		
22		A2			B3		C3			D2	
23		A2			B3			C4	D1		
24		A2			B3			C4		D2	
25		A2				B4	C3		D1		
26		A2				B4	C3			D2	
27		A2				B4		C4	D1		
28		A2				B4		C4		D2	
29	A1					B4	C3		D1		S1A
30	A1					B4	C3		D1		S1B
31	A1					B4	C3		D1		S1B-ALT1
32	A1					B4	C3		D1		S1C
33	A1					B4	C3		D1		S1C-ALT1
34	A1					B4		C4	D1		S1A
35	A1					B4		C4	D1		S1B
36	A1					B4		C4	D1		S1B-ALT1
37	A1					B4		C4	D1		S1C
38	A1					B4		C4	D1		S1C-ALT1

Figure 3 - SMRT Project Case Matrix

For cost and time reasons, the Study Group decided against evaluating the injection capability of each individual element. Instead, the Study objectively identified thermal overloads within the study area caused by additional resource injections under normal (N-0) and contingency (N-1) conditions for the various configurations that were evaluated. Element A, in its A1 configuration, which included 230-kV line additions in the WMIDD and IID areas, was included as part of the study Base Case; therefore, the incremental injection capability results are applicable to the combined Elements B, C and D.

Moreover, because the various elements and configurations comprising the SMRT Project are diverse and unique, the scope did not include identifying an optimal system configuration or

timing of the proposed element. Neither did the scope include determining which variations of the elements performed best compared to other variations.

Study Approach

The Study approach consisted of a two-step process in which the results from the first step were used as the basis for analysis in the second step. In the first step, a shift factor analysis was performed on the Collector Injection Buses and all other substations greater than 69-kV within the study area to determine the maximum non-simultaneous injection capability of the existing transmission system with Element A1 included (the Base Case or Pre-SMRT Case). The non-simultaneous injection results for the Collector Injection Buses were then used to determine the simultaneous injection capability, again using shift factor analyses. In this step-2 analysis, injections at the Collector Injection Buses were increased simultaneously in 10 per cent increments until an overload occurred within the study area. The simultaneous injection capability was then determined at the actual in-between percentage that caused line overloads to begin. In applying the percentages, the injections at each Collector Injection Bus maintained the same ratio (i.e., adjusted on a pro-rata basis) to the adjusted total injection as indicated in the step-1 non-simultaneous results.

For the simultaneous analysis, the injections of new renewable resources were assumed to displace generation in three market areas: (i) one-seventh being displaced in Nevada, (ii) two-sevenths being displaced in Arizona, and (iii) four-sevenths being displaced in Southern California. No generation displacements were assumed for the non-simultaneous analysis. In both analyses, N-1 contingencies were performed to determine thermal overloads and the level of overloads under both normal (N-0) and contingency (N-1) conditions.

The results of the non-simultaneous and simultaneous injection analyses of the Base Case established a baseline injection capability that was used as the basis for measuring the incremental injection capabilities of the various configurations listed in Figure 4 (the Post SMRT Cases). The same two-step (i.e., non-simultaneous and simultaneous) analyses were performed on the Post SMRT Cases to determine the expected incremental resource injection capability with all SMRT elements included.

Positive Sequence Load Flow (PSLF) was used to verify the injections and system reaction for the non-simultaneous Base Case results for the Collector Injection Buses.

Summary of Study Results

The detailed non-simultaneous and simultaneous study results for the Base Case and each of the Post SMRT Cases are contained in the Appendix.

Base Case

The non-simultaneous study results for the Base Case are summarized for the Collector Injection Buses in Table 1.

The simultaneous results for the Base Case indicated that overloads of transmission lines in the study area would first occur at approximately 67 per cent of the non-simultaneous level, indicating a simultaneous injection capability of 8,015 MW for Collector Injection Buses in the 10 REZs.

REZ	Injection Bus Number	Name	kV	Control Area	Zone	Max Injection Amount (MW)
1	24042	Eldorado	500	24	240	2182
	19038	Mead	500	14	191	2320
2	19022	Davis	230	14	191	349
3	25405	Iron Mtn.	230	24	248	113
4	19042	Parker	230	14	191	708
5	19020	Blythe	161	14	191	359
	19046	Bouse	161	14	191	205
6	19204	Harcuvar	230	14	191	495
7	22360	Imperial Valley	500	22	227	1416
8	22536	N. Gila	500	22	227	1180
9	15021	Palo Verde	500	14	910	2344
10	19320	Topock	230	14	191	228
Total Injection Amount						11899

Table 1 - Base Case Maximum REZ Injections

Post SMRT Project and Sensitivity Cases

The non-simultaneous study results for Post SMRT Case A1-B4-C3-D1, which showed the highest simultaneous injection capability for a non-sensitivity case, are summarized for the Collector Injection Buses in Table 2. Each of the Post SMRT and sensitivity cases has a similar table included in the body of the main report.

The simultaneous results for the A1-B4-C3-D1 Case indicated that overloads of transmission lines in the study area would first occur at approximately 42 per cent of the non-simultaneous level under n-1 conditions, indicating a simultaneous injection capability of 17,577 MW for Collector Injection Buses in the 10 REZs. When compared to the Base Case, this represents a incremental increase in injection capability of 9,562 MW. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line.

REZ	Injection Bus Number	Name	kV	Control Area	Zone	Max Injection Amount (MW)
1	24042	Eldorado	500	24	240	3932
	19038	Mead	500	14	191	3994
2	19022	Davis	230	14	191	933
3	25405	Iron Mtn.	230	24	248	514
4	19042	Parker	230	14	191	2985
	19910	Parker	500	14	191	3788
5	24900	Colorado River	500	24	800	3610
	19908	Bouse	230	14	191	2478
6	83005	Harcuvar	500	14	191	2434
	19204	Harcuvar	230	14	191	2746
7	83026	CTP 500	500	14	800	3493
8	22536	N. Gila	500	22	227	3591
9	15021	Palo Verde	500	14	910	3772
10	19912	Topock	500	14	191	3920
Total Injection Amount						42190

Table 2 - A1-B4-C3-D1 Case Maximum REZ Injections

Table 3 summarizes the total calculated non-simultaneous, simultaneous and incremental injection capabilities for the Base Case and for each of the Post-SMRT Project and sensitivity cases. In this table, the highlighted values indicate that the limiting line-overload occurs under normal (N-0) conditions.

Case	Max Inject REZ Non-Simultaneous (MW)	Max Inject REZ Simultaneous (MW)	Increase Over Base Case (MW)
Base Case (2019HS SWAT)	11,899	8,015	0
A1-B1-C3-D1	38,790	17,253	9,238
A1-B1-C3-D2	39,428	17,051	9,036
A1-B1-C4-D1	46,685	16,792	8,777
A1-B1-C4-D2	46,776	16,919	8,904
A1-B2-C3-D1	40,153	17,218	9,203
A1-B2-C3-D2	40,150	17,157	9,142
A1-B2-C4-D1	48,821	16,290	8,275
A1-B2-C4-D2	48,900	16,022	8,007
A1-B3-C3-D1	41,827	17,442	9,427
A1-B3-C3-D2	41,921	17,381	9,366
A1-B3-C4-D1	50,213	16,381	8,366
A1-B3-C4-D2	50,307	16,134	8,119
A1-B4-C3-D1	42,190	17,577	9,562
A1-B4-C3-D2	42,179	17,508	9,493
A1-B4-C4-D1	45,219	16,253	8,238
A1-B4-C4-D2	49,893	16,966	8,951
A2-B1-C3-D1	39,170	17,140	9,125
A2-B1-C3-D2	39,329	17,114	9,099
A2-B1-C4-D1	46,643	16,727	8,712
A2-B1-C4-D2	46,763	16,833	8,818
A2-B3-C3-D1	41,913	17,181	9,166
A2-B3-C3-D2	42,000	17,125	9,110
A2-B3-C4-D1	50,315	16,247	8,232
A2-B3-C4-D2	50,401	15,968	7,953
A2-B4-C3-D1	42,165	17,431	9,416
A2-B4-C3-D2	42,212	17,406	9,391
A2-B4-C4-D1	49,782	16,641	8,626
A2-B4-C4-D2	49,872	16,747	8,732
A1-B4-C3-D1-S1A	44,657	19,083	11,068
A1-B4-C3-D1-S1B	44,433	19,208	11,193
A1-B4-C3-D1-S1B-ALT1	44,305	19,335	11,320
A1-B4-C3-D1-S1C	44,605	19,565	11,550
A1-B4-C3-D1-S1C-ALT1	44,460	19,623	11,608
A1-B4-C4-D1-S1A	45,519	18,952	10,937
A1-B4-C4-D1-S1B	45,307	19,097	11,082
A1-B4-C4-D1-S1B-ALT1	44,043	19,009	10,994
A1-B4-C4-D1-S1C	45,390	19,418	11,403
A1-B4-C4-D1-S1C-ALT1	44,150	19,260	11,245

Table 3 - Case Injection Comparison

Conclusions

- The PSLF verification process concluded that all injections amounts showed accuracies of greater than 90 per cent.
- The Post SMRT Project cases indicated an incremental increase in the range of 8,000 – 9,500MW of simultaneous injection capability within the study area. Based on the PSLF verification process results, the incremental increase would be accurate within 10 percent of a study conducted using PSLF as the analysis tool.
- The Las Vegas to Los Angeles Double Circuit 500-kV sensitivity cases indicated an incremental increase (compared to the Post SMRT Project cases) in the range of 1,500 – 3,000MW of simultaneous injection capability within the study area.
- The existing N. Gila– Imperial Valley 500-kV line was the first transmission branch within the SMRT study system to exceed its ratings in each of the 28 Post SMRT Project cases and in each of the 10 Sensitivity Cases; and, within the accuracies of the study's methodology, equally limited the maximum simultaneous Renewable Energy Zone (REZ) injections under either N-0 or N-1 conditions.
- The indicated increase in simultaneous injection capability for the 28 variations of Post SMRT Project cases were within 10 per cent of each other.
- Injection points for REZ 1 (Eldorado, Mead), for REZ 4 (Parker), and for REZ 5 (Bouse, Colorado River, Mid Point AZ) consistently showed the highest Post SMRT non-simultaneous injection capabilities.
- Of the 12 WECC Rated Paths monitored, only Path 46 (West of River) showed potential overload issues.
- Injections at the Palo Verde Hub indicated that approximately 67 per cent of the injection flowed west along the East of River WECC path (Path 49) under non-simultaneous conditions but does not result in an overload condition.

Next Steps

A possible next step is to analyze one or more of the elements or a combination of elements in more detail with the intention of defining an "actionable" project for participation and funding. For an actionable project to be defined, with participation and funding in place, the required study work is likely to include a project-specific feasibility study, a system impact study, a facilities study and, perhaps, a separate cost/benefit analysis. These studies would include power flow, short circuit, stability and post-transient analyses. If a cost/ benefit study is required, a production cost analysis, taking into account transmission constraints, will also be required.

As transmission projects move through the various planning stages, coordination requirements among the regional planning groups as well as the ongoing study efforts being undertaken by others must also be addressed. Some of that coordination is already reflected in this Study effort; but much more coordination will be needed before any components of the SMRT Project can move forward to completion.

INTRODUCTION

Background

The "American Reinvestment and Recovery Act of 2009" granted the Western Area Power Administration (Western) borrowing authority of up to $3.25 billion to upgrade or expand the existing transmission system for the purpose of interconnecting to new renewable energy sources. Western received this authority from Congress in February 2009 and created the Transmission Infrastructure Program (TIP). Through a Request for Interest process, Western received numerous Statements of Interest (SOI) regarding potential transmission projects in the Southwestern United States. In an effort to identify where common interests in service on the transmission system would best be served, Western identified a number of major transmission elements being proposed. The parties eventually formed the Sonoran-Mojave Renewables Transmission Project (SMRT). Nine public and private power firms/entities and the U.S. Department of Energy Solar Technologies Program voluntarily joined together to define and fund a preliminary feasibility study (Study) to determine the technical merits of this potential regional effort.

Arizona Public Service
Citizens Energy
21st Century Transmission
Imperial Irrigation District Salt River Project
Solar Energy Technologies Program[4], Office of Energy Efficiency and Renewable Energy,
U.S. Department of Energy
Starwood Energy Group
Trans-Elect Development Company LLC/Energy Investors Funds
Wellton-Mohawk Irrigation and Drainage District
Western Area Power Administration, Federal Power Marketing Administration,
U.S. Department of Energy

The five major transmission elements[5] that emerged from an initial evaluation of the submissions with geographic proximity are:

- Element A - Hassayampa – N.Gila #2 500-kV Line
- Element B – Palo Verde – Blythe Area (Arizona portion of the Palo Verde – Devers #2 500-kV Line)
- Element C – Rebuild/Upgrade of the Western Colorado River Transmission System (Mead – N.Gila)
- Element D – Imperial Valley Renewable Transmission Project (N.Gila – Devers/Imperial Valley)
- Element S – Las Vegas to Los Angeles Double Circuit 500-kV

[4] The mission of the DOE Solar Energy Technologies Program is to conduct aggressive research, development, and deployment of solar energy technologies and systems to significantly reduce the cost of solar electricity by 2015. Visit http://www1.eere.energy.gov/solar/index.html for more information.

[5] The Study Group identified the major transmission system Elements A-D; and, Element S was then added as a sensitivity.

In addition to the four major transmission elements the members agreed to include a sensitivity element to determine delivery of power from the Las Vegas area to the Los Angeles Area, Element S. A composite of the SMRT Project, showing a variation of the four elements and the sensitivity, is depicted in Figure 5.

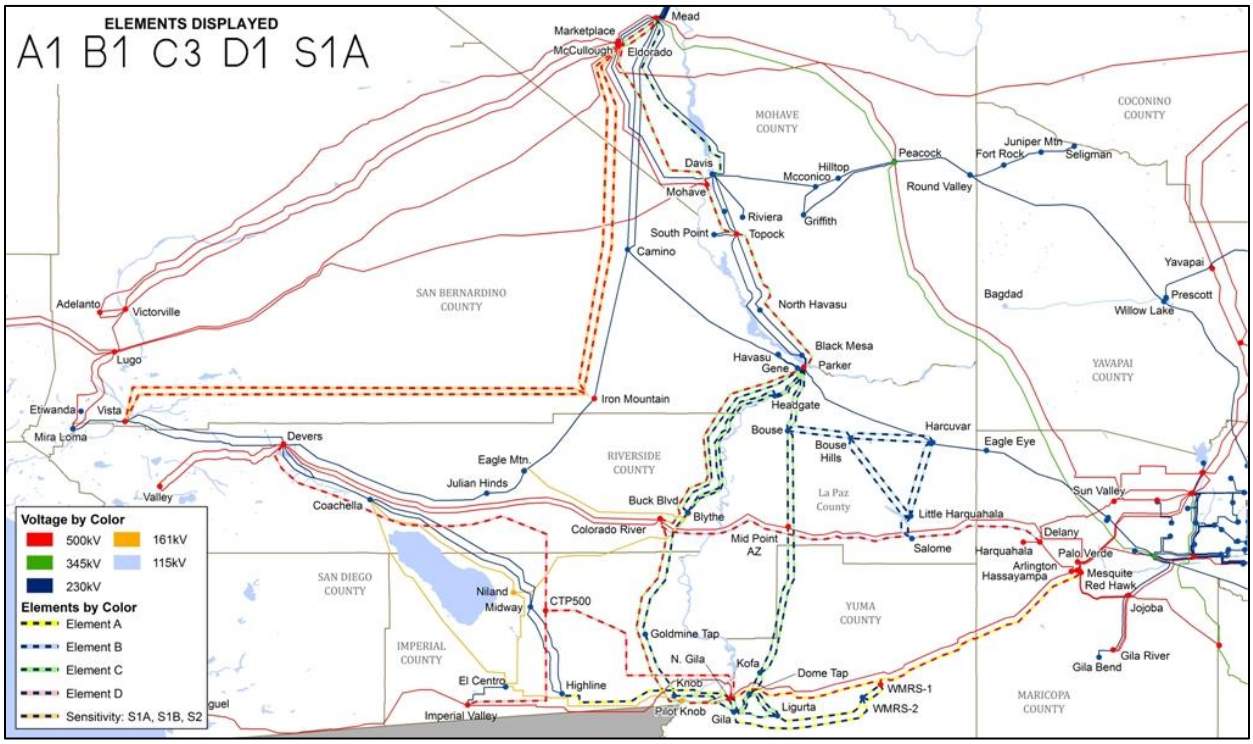

Figure 4 - SMRT Project with A1-B1-C3-D1-S1A Configuration

Study Scope and Objectives

The purpose of the SMRT study was to perform a Preliminary Feasibility Study to test the feasibility and analyze the proposed transmission elements that potentially could comprise the SMRT Project. The study was performed based on a study scope created and approved by the study participants. The study scope had three primary objectives:

1) Perform power system technical analyses to determine the simultaneous and non-simultaneous maximum generation injection capability in the pre-defined resource zones.
2) Determine effects on major transmission paths such as East of River (EOR) and West of River (WOR).
3) From the results of 1 and 2 above, evaluate the viability of the proposed SMRT project to accomplish the goal to interconnect load centers to regional markets.

During the study scope formulation, each participant had opportunity to provide input on possible variations as to how each of the elements would be configured. The participants decided that the Study would first test and analyze the project as a whole without testing individual elements or their variations. Then, after examining the potential variations of each element, the participants determined that there would be between 2 and 4 variations for each of the four transmission elements. Each of the four transmission elements and their variations are

described in detail and graphically depicted in the section entitled “Study Cases”. Lastly, plans called for 10 sensitivities to be performed on additional facilities that would transfer power from Las Vegas to Los Angeles.

This Study gives project proponents a relative measure of how the various element combinations compare to one another and either identifies or alleviates early concerns of feasibility and/or desirability of the various element combinations. Also, this Study could provide a “springboard” for the coordination of projects going forward.

Study Limitations

While it is important to understand what is to be accomplished by meeting the Study objectives, it is equally as important to understand what the Study does **not** accomplish.

- First, the calculated injection levels presented in the Study results are for comparison purposes only and should not leave the impression that such levels can be obtained simply by adding the proposed SMRT facilities. There are many factors to consider in addition to the thermal transfer capability of the transmission system in one region. (See the following discussions on *Contractual Limits* and *Modern Day Transmission Constraints*)
- The study requirements and project development processes for adding new transmission and new generation facilities are extensive, and this Study will not enable side-stepping or diminishing any of those requirements.
- The SMRT participants chose to use a single case representing a heavy summer 2019 scenario because it represents the planned and proposed facilities in the study area. In addition, the starting case was approved by the regional planning group, Southwestern Area Transmission (SWAT), for the study area. Other years or seasons may result in different injection capabilities.
- Delays or advances of the in-service dates for the various elements could result in different injection capabilities.
- The study does not assess the cost of the project nor does it assess the potential business value of the project.
- Finally, transmission planning is a continual, ongoing process that must keep up with the increasingly complex demands placed on electrical systems. This Study should be viewed in that context. Changes to the planned and proposed facilities could have an impact on the injection capabilities.

Contractual Limits

This Study, like other studies that identify physical system limitations, does not address any of the contractual issues that limit transfer capability. Nevertheless, contractual limits are real; and it should be understood that “latent” capacity, such as the injection capability identified for the Pre-SMRT case, is not simply “up for grabs.” Much of the “latent” capacity is used or reserved for other purposes (e.g., reserve sharing obligations, access to different markets, etc.).

More importantly, the characteristic of interconnected AC systems is that they all rely on each other to some extent. This inter-dependence suggests a “quid pro quo” arrangement that is

mostly unavoidable,[6] but one that receives careful scrutiny throughout the planning process to insure that parallel flows are not abusive, especially with respect to future contract paths. In this context, the injection capability at a given bus may be limited by the path that is available for its delivery to load.

Modern Day Transmission Constraints

Historically, the physical limits on delivering generation to load have been characterized by a lack of thermal or stability transfer capability and area import capability. These types of limits still exist and, if anything, have increased as access to the numerous power producers participating in today's marketplace has increased. However, as the new energy policies unfold with mandates for renewable energy resources, the types of constraints on delivering energy from new resources to load centers are becoming more complex, and cannot be addressed simply by adding more transmission. This is especially true for renewable energy resources (e.g., PV solar and wind generation) that do not provide spinning inertia to the system. While many concepts (such as energy storage devices and rapid-start combined-cycle units) are being considered to accommodate the addition of large-scale renewable energy projects, the higher penetration levels will create problems that additional transmission alone cannot resolve. These problems have already surfaced in places such as California and Texas where large concentrations of wind energy have been installed. Typically, the problem is one of "over-generation" when loads are low and the system is most vulnerable to disturbances[7]. For example, the Electric Reliability Council of Texas (ERCOT) has included the following definition in its Nodal Protocols, to address **non-thermal** constraints.[8]

> **Generic Transmission Limit (GTL)**
>
> A transmission flow limit more constraining than a Transmission Element's normal limit established to constrain flow between geographic areas of the ERCOT Transmission System that is used to enforce stability and voltage constraints that cannot be modeled directly in ERCOT's transmission security analysis applications.

Next Steps

A possible next step is for one or more of the elements or a combination of elements to be moved forward for more detailed analysis with the intention of defining an "actionable" project for participation and funding. For an actionable project to be defined, with participation and funding in place, the required study work is likely to include a project-specific feasibility study, a system impact study, a facilities study and, perhaps, a separate cost/benefit analysis. These studies would include power flow, short circuit, stability and post-transient analyses. If a cost/

[6] The control devices (e.g., phase shifters) are used in certain instances to avoid "leaning" on adjacent system(s).

[7] See the "California Independent System Operator Renewable Integration Study" for "Achieving California's 20 per cent Renewable Portfolio Standard" at http://www.caiso.com/1c64/1c64e60aa4c0.pdf.

[8] See the current ERCOT Nodal Protocols at http://www.ercot.com/mktrules/nprotocols/current.

benefit study is required, a production cost analysis, taking into account transmission constraints, will also be required.

As transmission projects move through the various planning stages, coordination requirements among the regional planning groups as well as the ongoing study efforts being undertaken by others must also be addressed. Some of that coordination is already reflected in this Study effort; but much more coordination will be needed before any components of the SMRT Project can move forward to completion.

STUDY AREA

The transmission elements for the SMRT Project are all located in Arizona, Nevada, or Southern California. This area encompasses most of Western's Desert Southwest (DSW) region, parts of the California Independent System Operator (CAISO), and areas served by the Imperial Irrigation District (IID) and Arizona Public Service Company (APS). The major market delivery points in the study area include the Palo Verde Hub located in Arizona, Mead-Market Place-El Dorado located in Southern Nevada, and Devers and Imperial Valley, both located in Southern California.

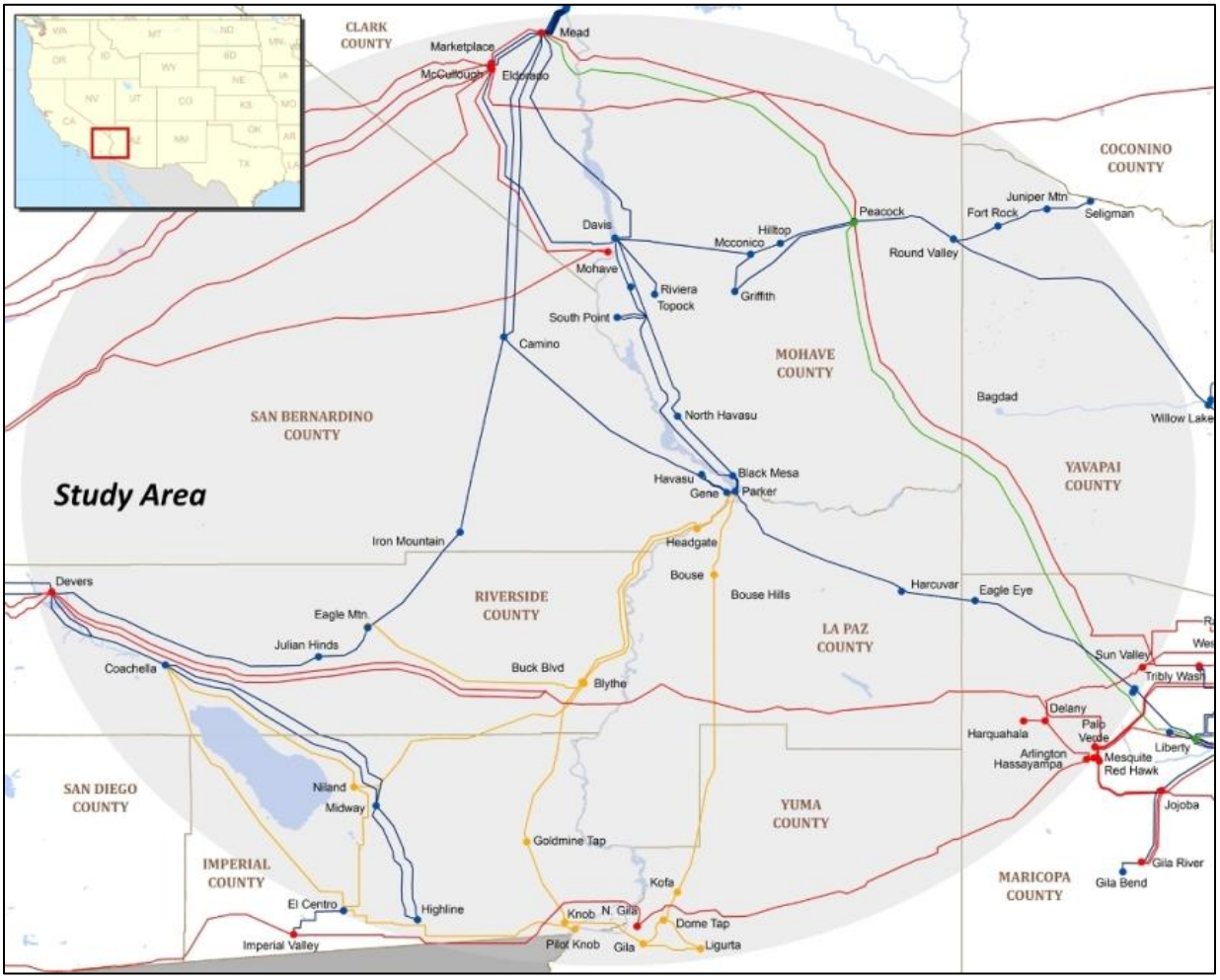

Figure 5 - SMRT Project Study Area

The SMRT Project consists of four new or upgraded transmission elements and one potential sensitivity element connecting the major market delivery points in Arizona, Nevada, and Southern California. The four transmission elements are connected to the various delivery points via a 500-kV backbone totaling approximately 900 miles. In addition, some portions of the elements would use additional 230-kV transmission lines to assist in transmission and generation collection. These 230-kV portions also total approximately 900 miles. The total

miles of transmission line depends on the variations of the elements. Each of the transmission lines is uniquely situated to take advantage of the renewable energy interconnections. The study defined 10 Renewable Energy Zones (REZ) located in the study area as depicted on the map below.

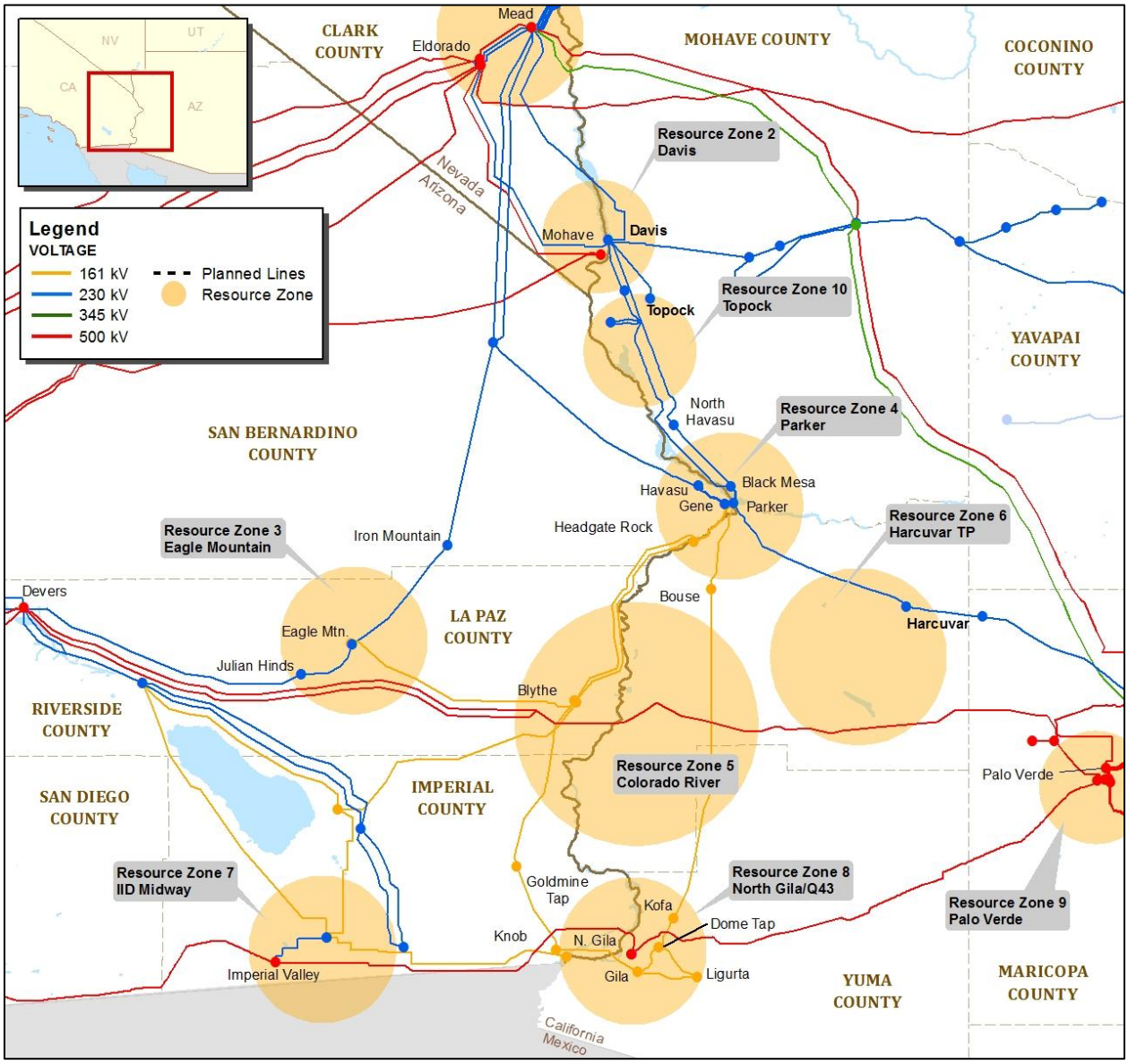

Figure 6 - SMRT Project Renewable Energy Zones

STUDY ASSUMPTIONS

The following assumptions were used when performing the testing and analysis of the study and compiling this report.

- All cases provided to KRSA had the proper pre-project modeling and topology representing the transmission system in the study area for the planned year. A description of the starting case and individual post project cases is provided in the following section, “Study Cases”.
- For purposes of preliminary feasibility, the limiting elements are confined to the study area as stated in the scope of work.
- Analysis of the four transmission elements in the 28 various configurations and 10 sensitivities would provide an adequate analytical base for proponents to compare the various SMRT Project options.

STUDY CASES

The SMRT Project Preliminary Feasibility Study consisted of one Base case to establish a baseline for comparisons, 28 Post-SMRT cases demonstrating the variations of each element, and 10 Sensitivity cases. The following descriptions briefly summarize the different element and sensitivity configurations analyzed in the study.

Element Configurations

Element A: Hassyampa – N. Gila Connection

The Hassayampa – North Gila line is the only transmission element in the SMRT study that was included in the base case as in service. The members of the SMRT Project agreed to place this element in the base case as in service because it has an expected in service date of 2014 which precedes the 2019 case chosen for the analyses. Element A consists of approximately 110 miles (A1) or 160 miles (A2) of 500kV transmission line with a 3,000 MVA continuous thermal rating and approximately 160 miles (A1) or 100 miles (A2) of 230kV transmission line with a 1,600 MVA continuous thermal rating.

- **A-1:** A 500-kV line from the Hassayampa 500-kV substation to the WMRS1 500/230-kV substation to the North Gila 500-kV substation. A double circuit 230-kV line from the WMRS1 substation to the WMRS2 230/69-kV substation located approximately 7 miles south of the WMRS1 substation. A single circuit 230-kV line from WMRS2 substation to the existing Ligurta substation. A single circuit 230-kV line from WMRS2 to the Gila230/161-kV sub (upgraded/rebuilding the existing Gila to Ligurta 161 kV line as a double circuit). A single circuit 230-kV line from N.Gila 500/230-kV substation to the Highline230-kV substation.

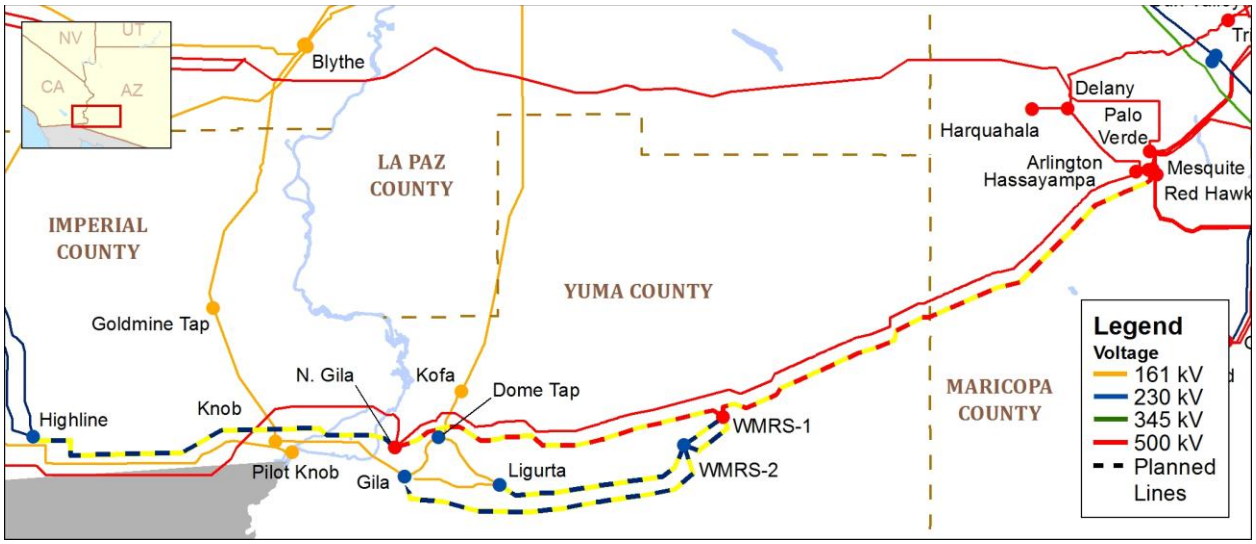

Figure 7 - A1 Element

- **A-2:** A 500-kV line from the Hassayampa 500-kV substation to the WMRS1 500/230-kV substation to the North Gila 500-kV substation. A single circuit 230-kV line from WMRS1 to North Gila. A double circuit 230-kV line from WMRS1 to WMRS2 substation, approximately 7 miles south. A single circuit 230-kV line from the existing North Gila substation to the existing Highline substation. A single circuit 500-kV line from the WMRS1 substation to the Salome substation.

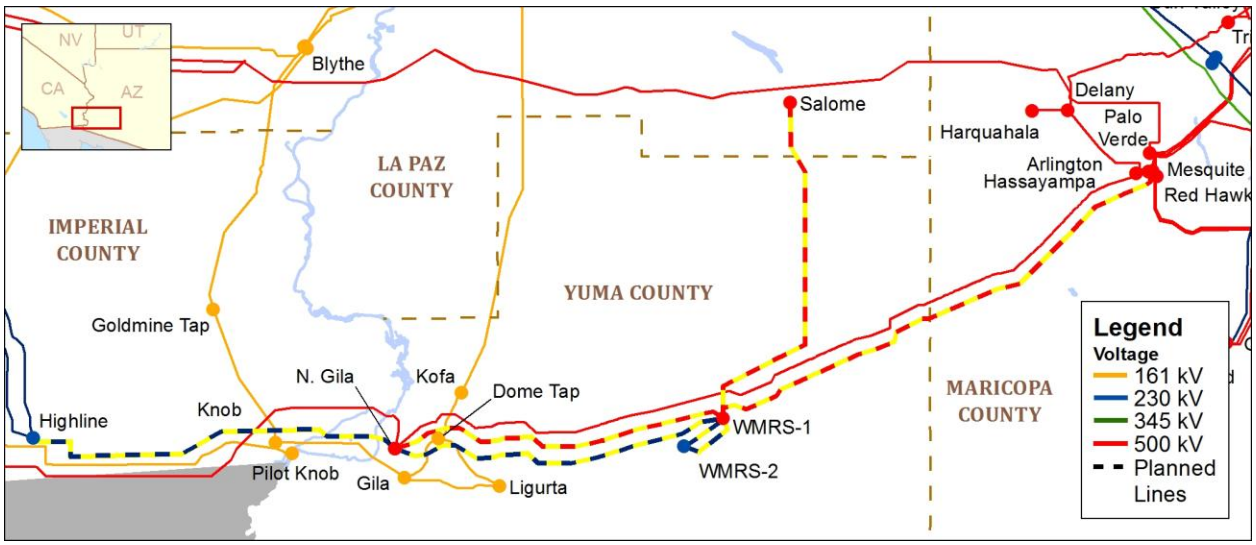

Figure 8 - A2 Element

Element B: 500-kV Palo Verde – Blythe area

Element B is the Arizona portion of the Palo Verde – Devers #2 line. In addition to the approved routing, the SMRT Project analyzed a northern route, and two combination routes consisting of part of the northern and southern routes. Element B consists of approximately 114 miles (B1), 172 miles (B2), 189 miles (B3), or 162 miles (B4) of 500kV transmission line with a 3,000 MVA continuous thermal rating and approximately 107 miles (B1 and B4) or 143 miles (B2 and B3) of 230kV transmission line with a 1,600 MVA continuous thermal rating.

- **B1 with C3 in-service:** A single circuit 500-kV line from Delany to the Salome substation continuing on to the Colorado River substation.
- **B1 with C4 in-service:** A single circuit 500-kV line from Delany to the Salome substation continuing on to Mid Point AZ substation. From Mid Point AZ 500/230-kV sub the line ends at the Colorado River / Mid Point substation.

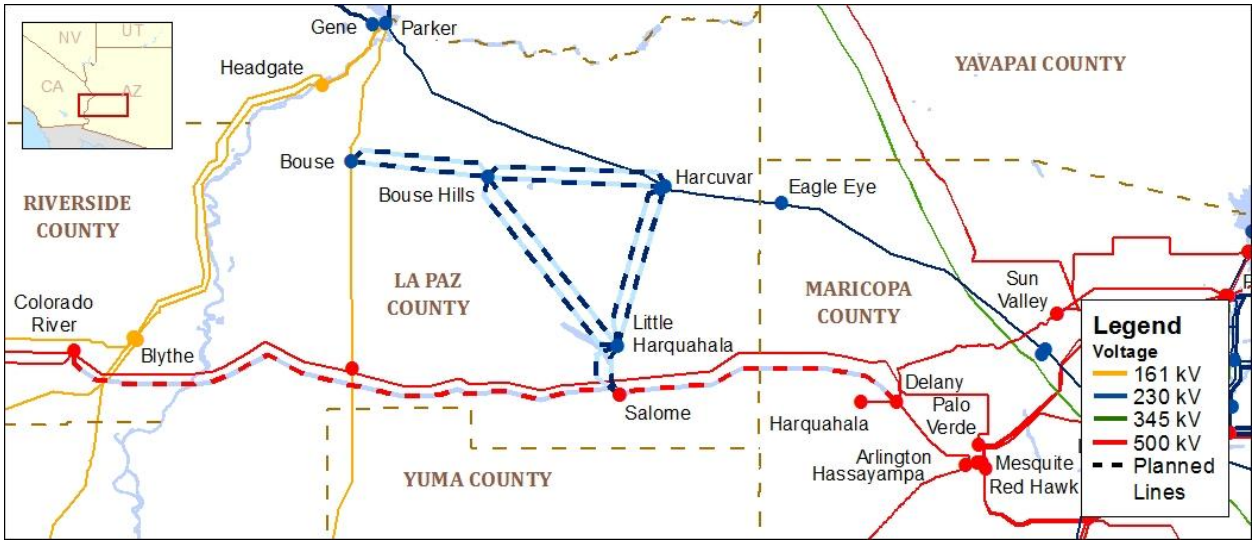

Figure 9 - B1 Element

- **B2 with C3 in-service:** A single circuit 500-kV line from TS5 (Sun Valley) substation to Harcuvar 500/230-kV substation continuing to the Parker 500/230-kV substation and ending at the Colorado River / Mid Point 500-kV substation. With the B2C3 configuration the Harcuvar Project does not have a double circuit 230-kV line from Little Harquahala sub to the Salome 500/230-kV sub in this element.
- **B2 with C4 in-service:** A single circuit 500-kV line from TS5 (Sun Valley) substation to Harcuvar 500/230-kV substation continuing to the Parker 500/230-kV substation and ending at the 500-kV substation. For the B2C4 configuration the Harcuvar Project has a double circuit 230-kV line from Salome 500/230-kV substation to Mid Point AZ 500/230-kV. With the B2C4 configuration the Harcuvar Project does not include a double circuit 230-kV line from the Little Harquahala substation to the Salome 500/230-kV substation.

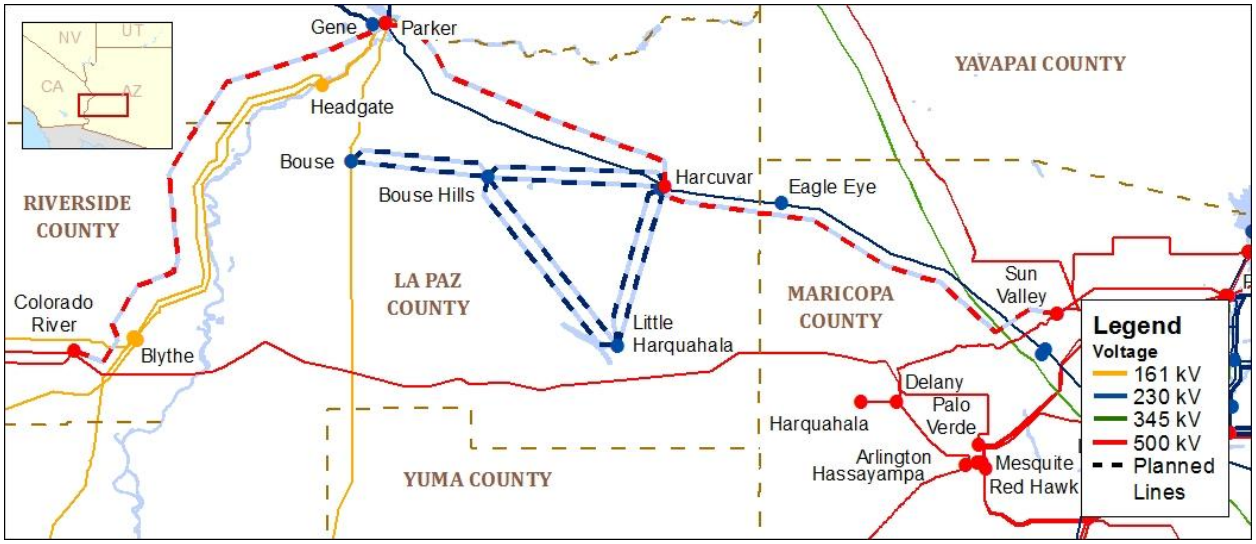

Figure 10 - B2 Element

- **B3 with C3 in-service:** A single circuit 500-kV line from Delany 500-kV substation to Salome 500/230-kV substation, Salome substation to the Harcuvar 500/230-kV substation continuing to the Parker 500/230-kV substation and ending at the Colorado River / Mid Point 500-kV substation.
- **B3 with C4 in-service:** A single circuit 500-kV line routed from the Delany 500-kV substation to the Salome 500/230-kV substation, from the Salome substation to the Harcuvar 500/230-kV substation and continuing to the Parker 500/230-kV substation and ending at the Colorado River / Mid Point 500-kV substation. Within the B3C4 configuration the Harcuvar Project contains a double circuit 230-kV line from Salome 500/230-kV substation to Mid Point AZ 500/230-kV substation.

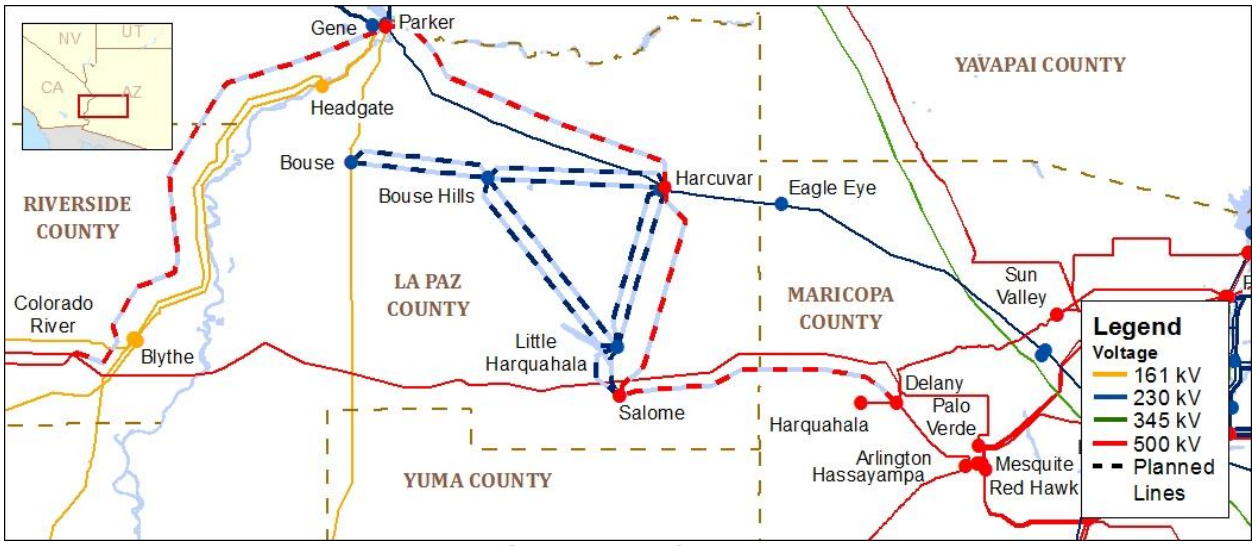

Figure 11 - B3 Element

- **B4 with C3 in-service:** A single circuit 500-kV line from the TS5 (Sun Valley) substation to the Harcuvar 500/230-kV substation continuing to the Salome 500/230-kV substation and ending at the Colorado River / Mid Point 500-kV substation.

- **B4 with C4 in-service:** A single circuit 500-kV line from the TS5 (Sun Valley) substation to the Harcuvar 500/230-kV substation and then continuing to the Salome 500/230-kV substation. From the Salome substation the line is routed to the Mid Point AZ 500/230-kV substation and ending at the Colorado River / Mid Point 500-kV substation.

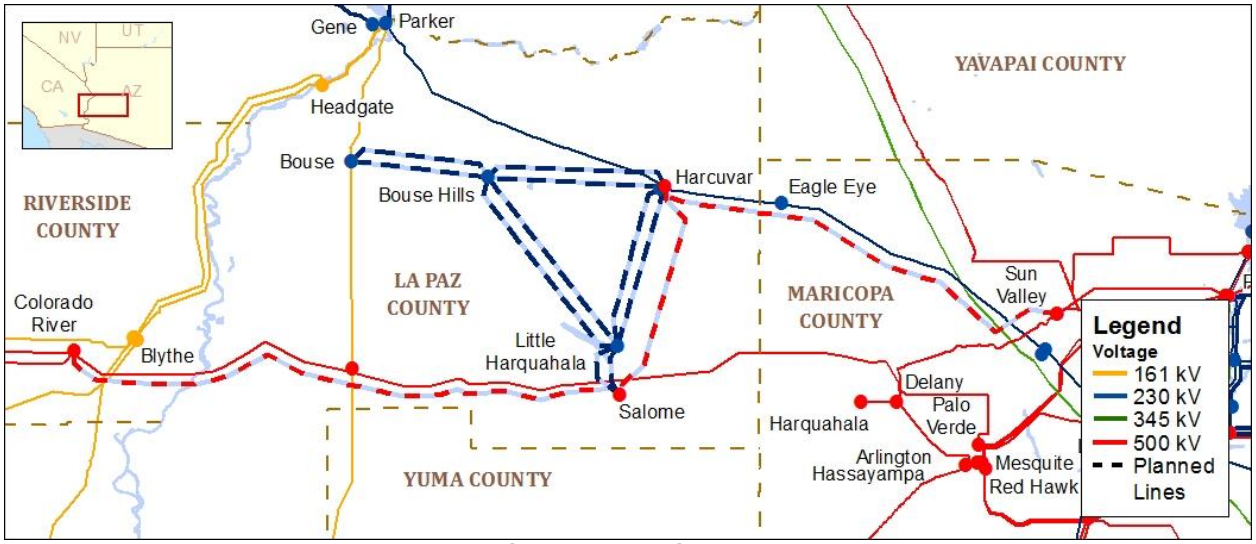

Figure 12 - B4 Element

Element C: Upgrades/Rebuilds/Replacements to existing Parker-Davis Transmission System

Element C consists of approximately 288 miles (C3) or 485 miles (C4) of 500kV transmission line with a 3,000 MVA continuous thermal rating and approximately 418 miles (C3) or 358 miles (C4) of 230kV transmission line with either 800MVA or 1,600MVA continuous thermal rating.

- **C-3 North of Parker:** A single circuit 500-kV line from Parker substation to Topock substation, then from Topock substation to Mohave substation and continuing to Eldorado substation. Two 500-kV lines (Eldorado-Mead 1 and 2) from Eldorado substation to Mead substation. A single circuit 230-kV line from Davis substation to Mead substation.
- **C-3 South of Parker**: A 500-kV double circuit with one side operated at 500-kV and the other operated at 230-kV. The double circuit 500/230-kV line begins with a 500-kV line from Parker substation to the Colorado River/Mid Point substation then to the North Gila substation. The 230-kV side of the 500/230-kV line is routed from Parker substation to Blythe substation, then to Gold Mine substation. The 230-kV line continues from Gold Mine substation to Knob substation, and then to Gila substation. A double circuit 230-kV line is routed from Parker substation to Headgate substation, then on to Blythe substation. A double circuit 230-kV line from Gila substation to Dome Tap substation. From Dome Tap substation the double circuit 230-kV line continues to Ligurta substation, and then back to Gila substation. A double circuit 230-kV line from Dome Tap substation to Kofa substation then to Bouse substation then continuing to Parker substation. A double circuit 230-kV line from Gila substation to North Gila substation.

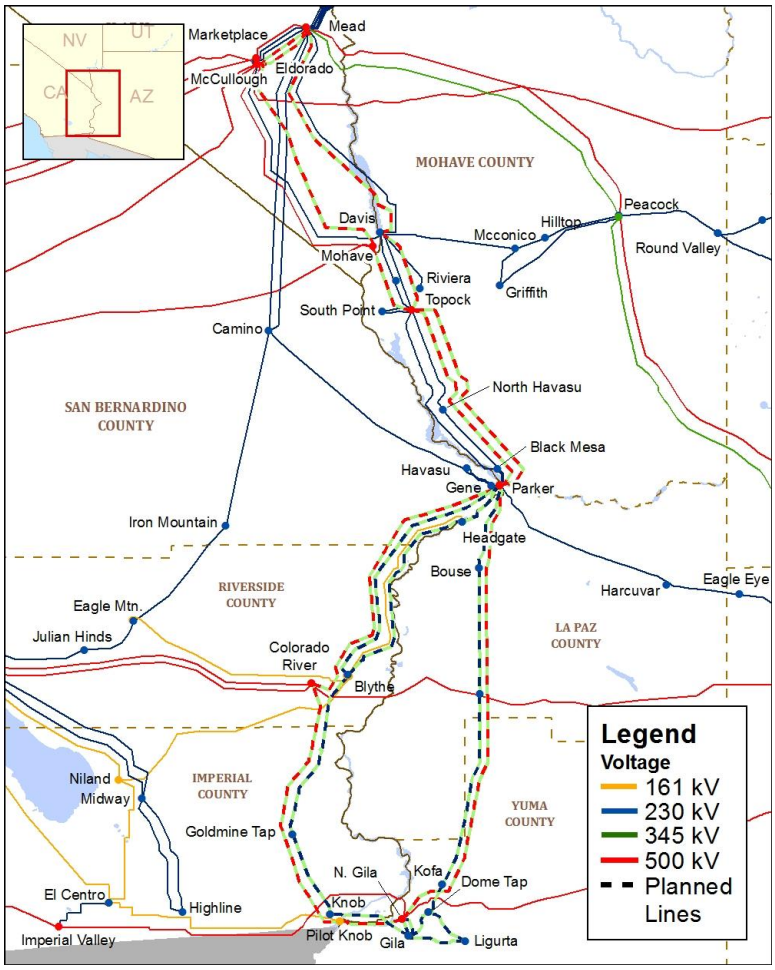

Figure 13 - C3 Element

- **C-4 North of Parker:** A double circuit 500-kV line from Parker substation to Topock substation. A single circuit 500-kV line from Topock substation to Mohave substation, then continuing to Eldorado substation. Two 500-kV lines (Eldorado-Mead 1 and 2) from Eldorado substation to Mead substation. A single circuit 500-kV line from Topock substation to Davis substation, then from Davis substation to Mead substation.

- **C-4 South of Parker:** A 500-kV double circuit with one side operated at 500-kV and the other operated at 230-kV. The double circuit 500/230-kV line begins with a 500-kV line from Parker substation to Colorado River/Mid Point substation then continuing to North Gila substation. From North Gila the 500-kV line is routed to Mid Point AZ then to Parker substation. The 230-kV side of the 500/230-kV line is routed from Parker substation to Blythe substation, then to Gold Mine substation, from Gold Mine substation to Knob substation, and continuing from Knob to Gila substation. The line continues from Knob to Dome substation then to Kofa substation. From Kofa substation the line is routed to Bouse substation then to Parker substation. A single circuit 230-kV line from Parker substation to Headgate substation continues to Blythe substation. A single circuit 230-kV line from Gila substation to Ligurta substation then from Ligurta substation continuing to

Dome Tap substation. A double circuit 230-kV line from Gila sub to North Gila substation.

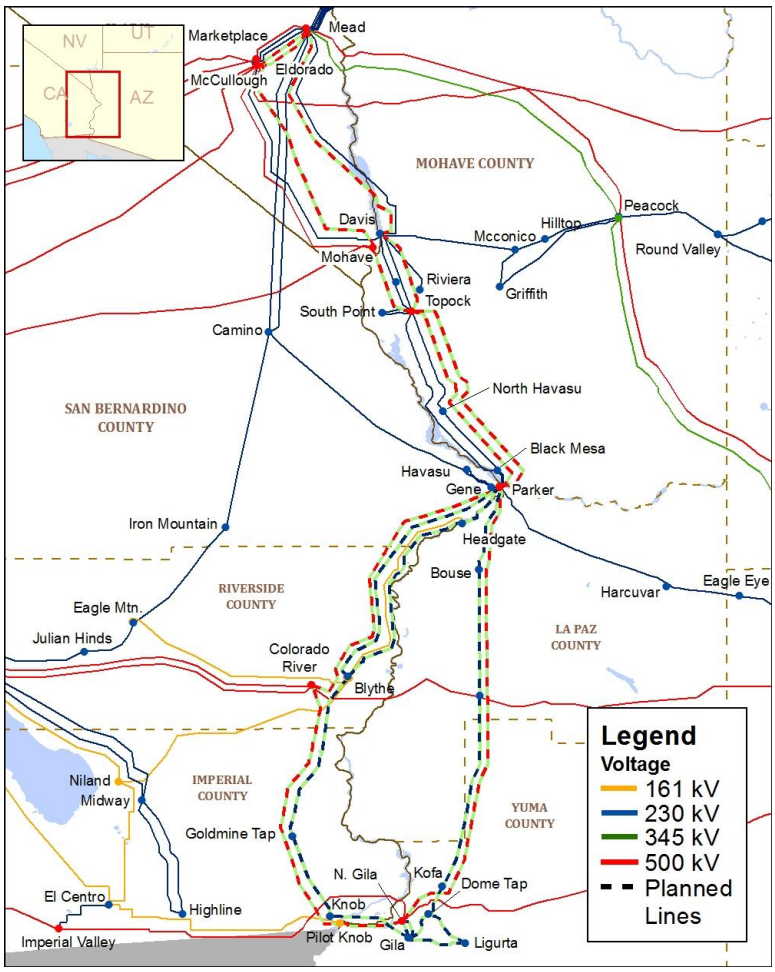

Figure 14 - C4 Element

Element D: Imperial Valley Renewables Transmission

Element D consists of approximately 219 miles (D1 and D2) of 500kV transmission line with a 3,000 MVA continuous thermal rating.

- **D-1:** Element D-1 consists of a single circuit 500-kV line from North Gila substation to a new CTP Midway Substation in Imperial Valley. From CTP Midway substation one single circuit 500-kV line is routed to the existing Devers substation and the other is routed to the existing Imperial Valley substation.

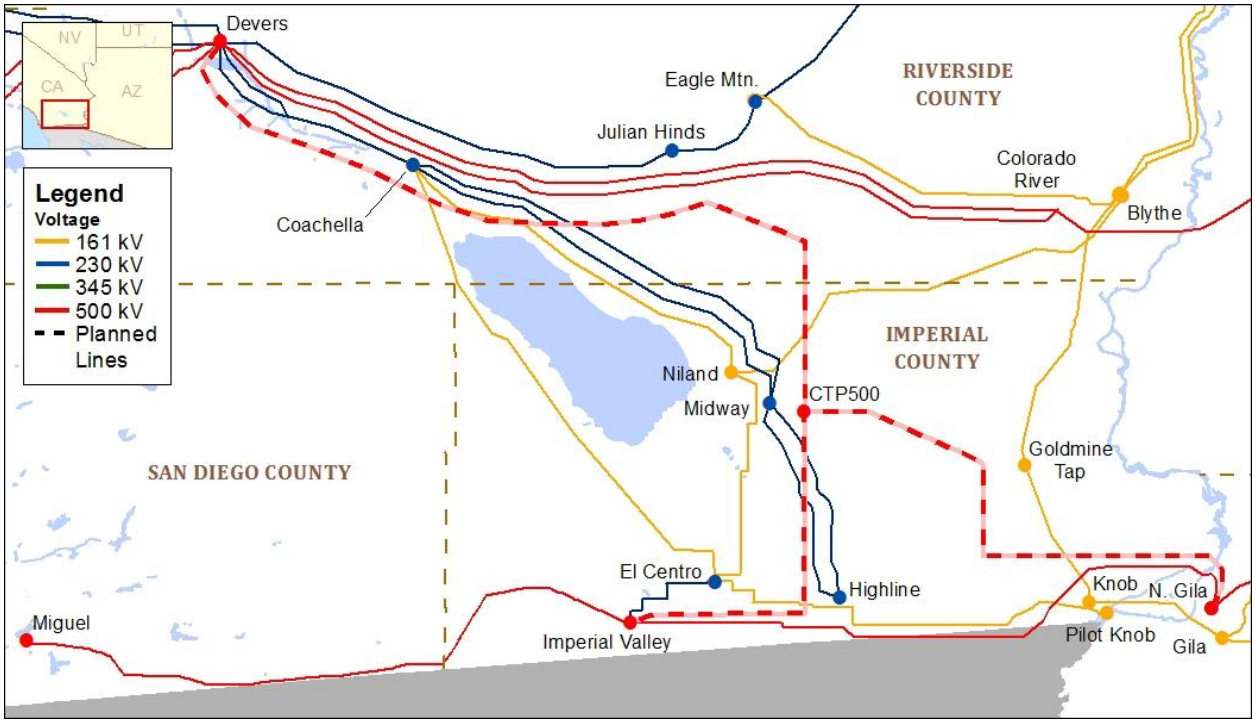

Figure 15 - D1 Element

- **D-2:** Element D-2 consists of a single circuit 500-kV line from North Gila substation to Gold Mine Tap substation, then from Gold Mine Tap to the new CTP Midway Substation. From the CTP Midway substation one single circuit 500-kV line is routed to the existing Devers substation and the other is routed to the existing Imperial Valley substation.

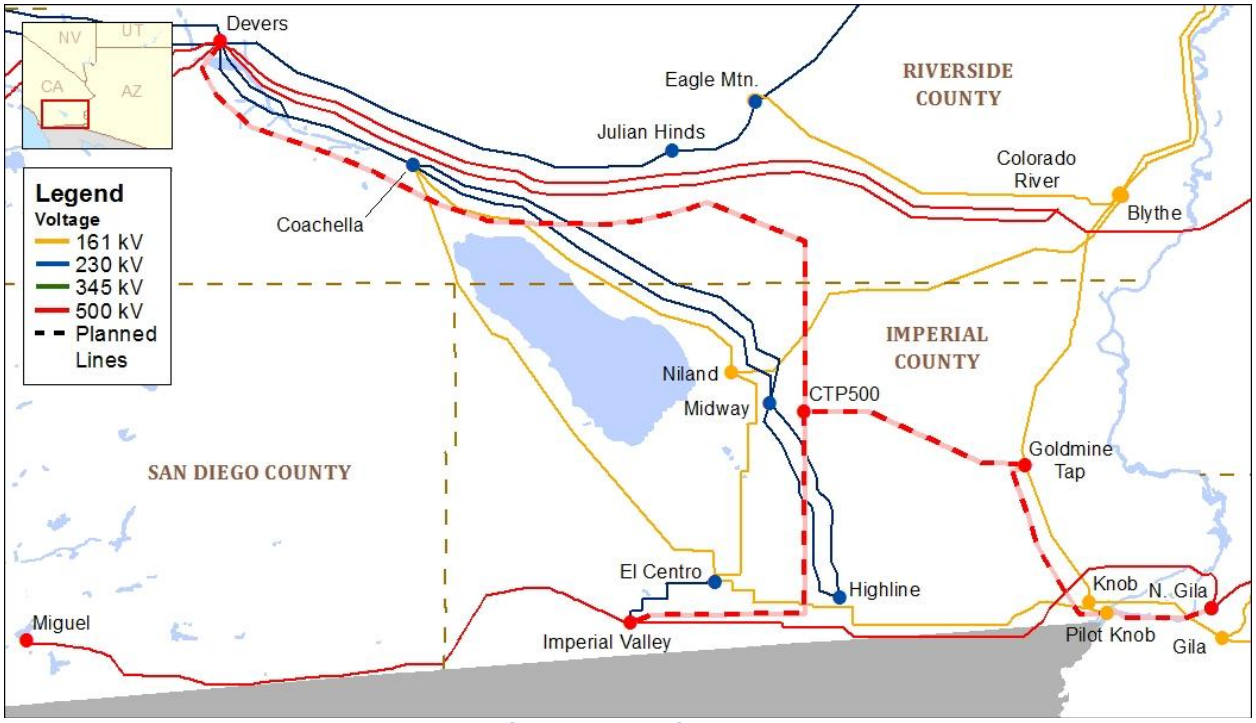

Figure 16 - D2 Element

Sensitivity Elements: Las Vegas to Los Angeles Transmission

- **C3 and C4 with S1A:** A double circuit 500-kV transmission line from Eldorado substation to Iron Mountain 500/230-kV substation. From Iron Mountain the double circuit 500-kV transmission line continues to the Rancho Vista substation.

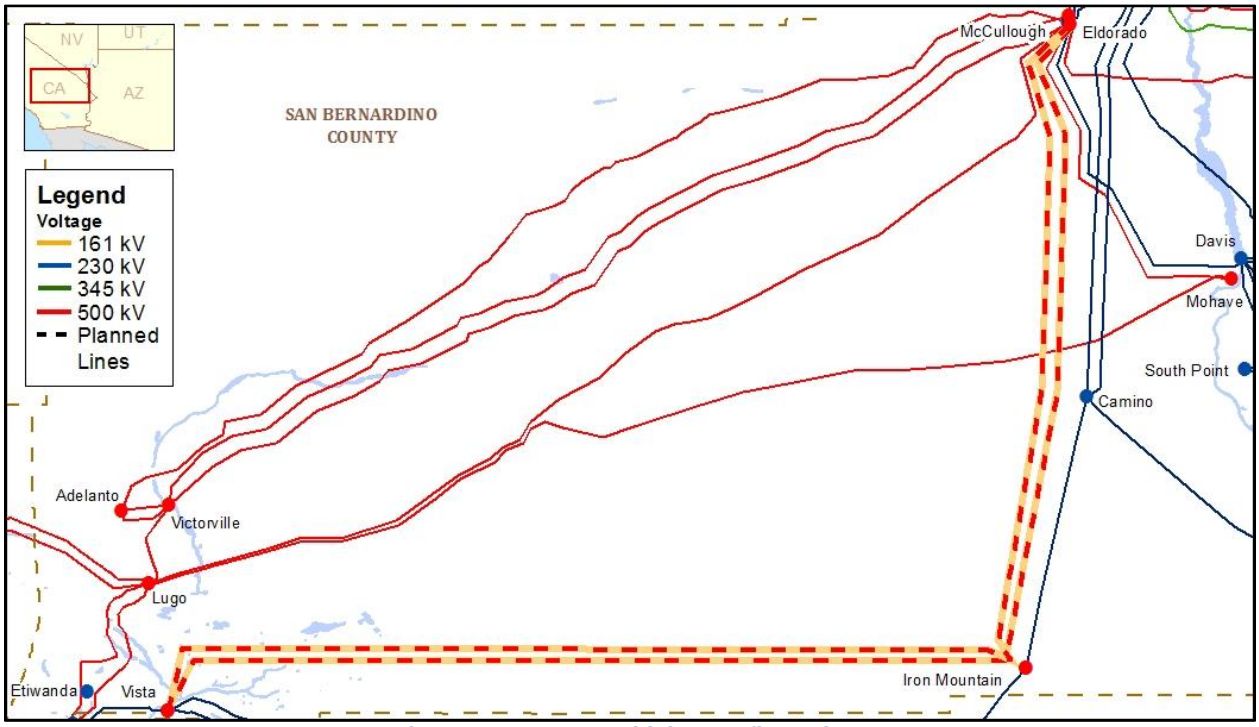

Figure 17 - S1A Sensitivity Configuration

- **C3 and C4 with S1B:** A second circuit from Eldorado 500-kV substation to Mohave 500-kV substation, a double circuit 500-kV line from Mohave substation to Iron Mountain 500/230-kV substation, a double circuit 500-kV transmission line from Iron Mountain to Rancho Vista substation, and a single circuit 500-kV transmission line from Eldorado substation to Iron Mountain 500/230-kV substation.

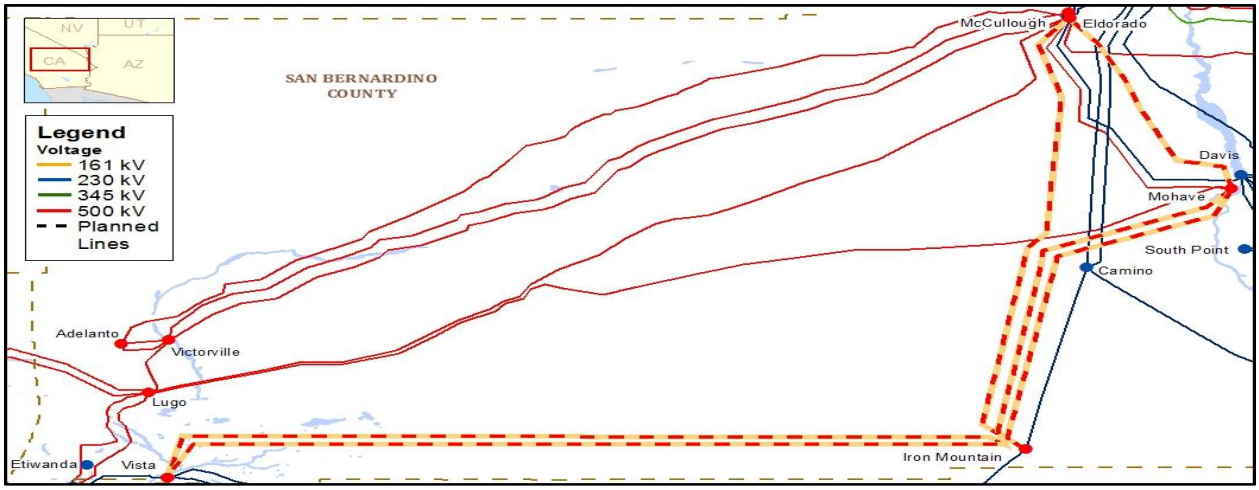

Figure 18 - S1B Sensitivity Configuration

- **C3 with S1B Alt 1:** A single circuit 500-kV line from Mead substation to Mohave substation. A double circuit 500-kV line from Mohave substation to Iron Mountain 500/230-kV substation, a double circuit 500-kV transmission line from Iron Mountain to Rancho Vista substation, a single circuit 500-kV transmission line from Eldorado substation to Iron Mountain 500/230-kV substation, a single circuit 500-kV transmission line from Mead 500-kV substation to Davis 500/230-kV substation, a single circuit 500-kV transmission line from Mohave 500-kV substation to Davis 500/230-kV substation, and a single circuit 500-kV transmission line from Davis 500/230-kV substation to Topock 500/230-kV substation.

- **C4 with S1B Alt 1:** A single circuit 500-kV line from Mead substation to Mohave substation. A double circuit 500-kV line from Mohave substation to Iron Mountain 500/230-kV substation, a double circuit 500-kV transmission line from Iron Mountain to Rancho Vista substation, a single circuit 500-kV transmission line from Eldorado substation to Iron Mountain 500/230-kV substation, and a single circuit 500-kV transmission line from Mohave 500-kV substation to Davis 500/230-kV substation.

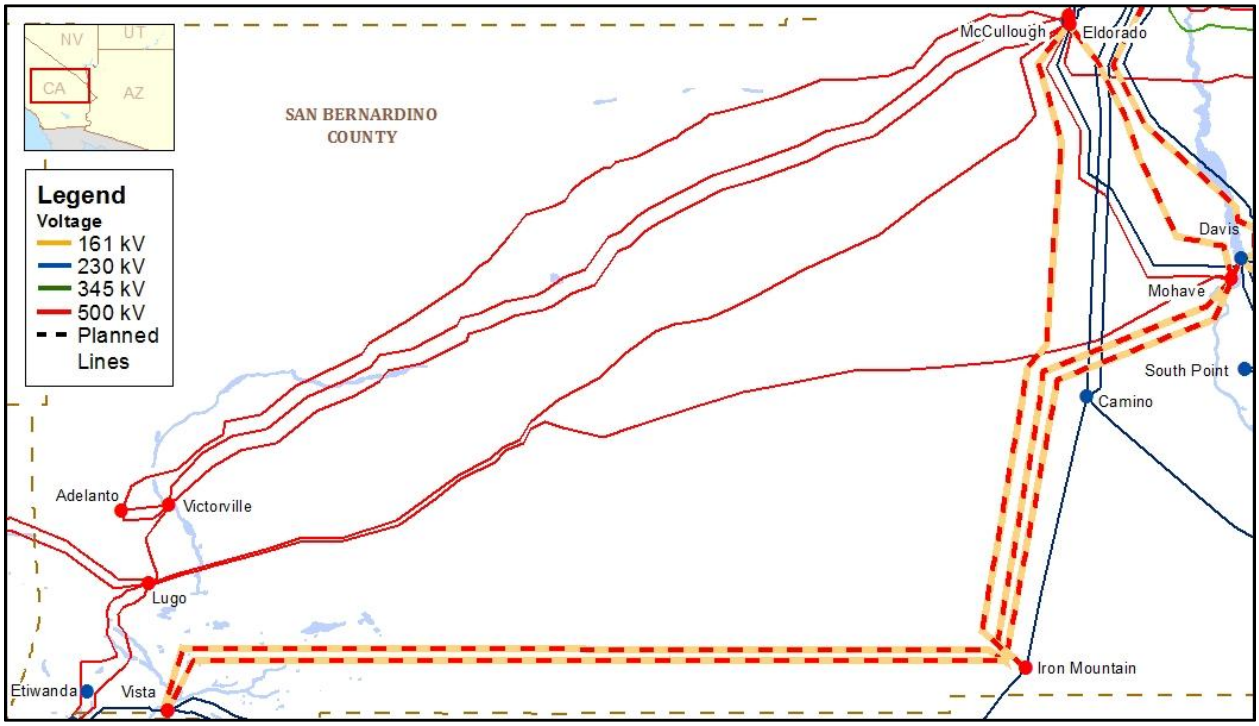

Figure 19 - S1B Alt 1 Sensitivity Configuration

- **C3 and C4 with S1C:** A second circuit from Eldorado 500-kV substation to Mohave 500-kV substation, a double circuit 500-kV line from Mohave substation to Iron Mountain 500/230-kV substation, a double circuit 500-kV transmission line from Iron Mountain to Rancho Vista substation, a single circuit 500-kV transmission line from Eldorado substation to Iron Mountain 500/230-kV substation, and a single circuit 500-kV transmission line from Iron Mountain 500/230-kV substation to Colorado River 500-kV substation.

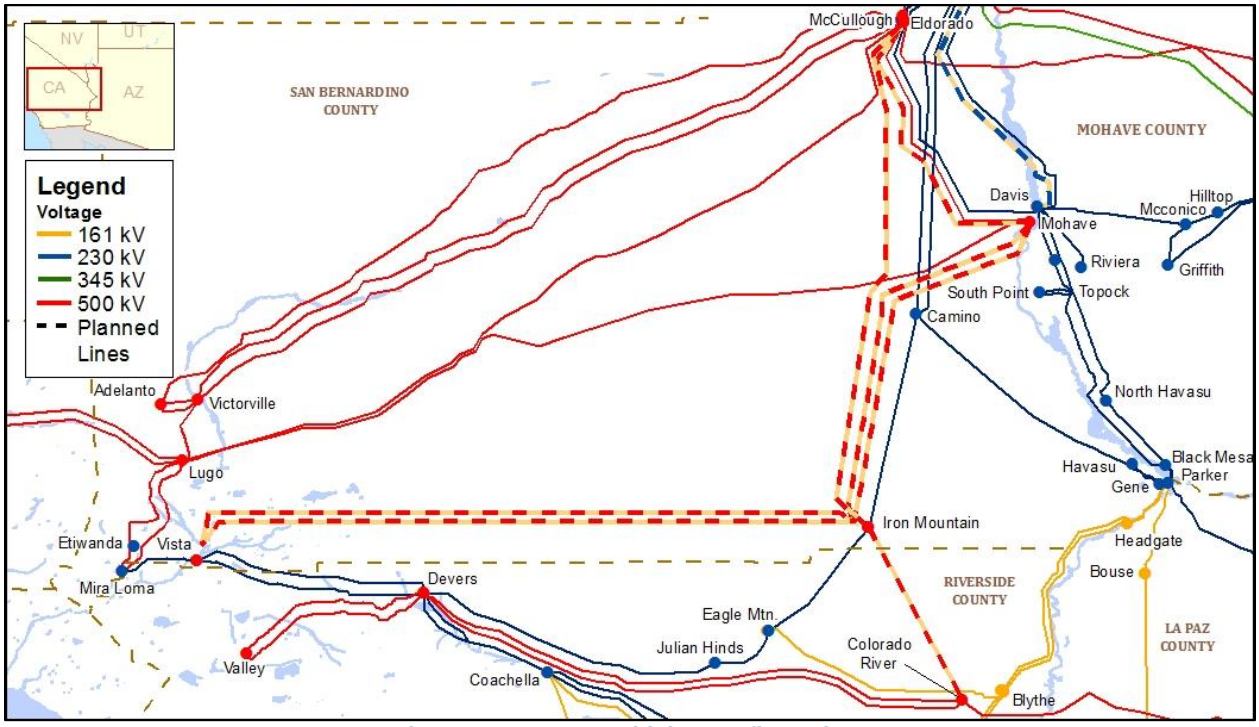

Figure 20 - S1C Sensitivity Configuration

- **C3 and C4 with S1C Alt 1:** A second circuit from Eldorado 500-kV substation to Mohave 500-kV substation, a double circuit 500-kV line from Mohave substation to Iron Mountain 500/230-kV substation, a double circuit 500-kV transmission line from Iron Mountain to Rancho Vista substation, a single circuit 500-kV transmission line from Eldorado substation to Iron Mountain 500/230-kV substation, and a single circuit 500-kV transmission line from Iron Mountain 500/230-kV substation to Colorado River 500-kV substation, a single circuit 500-kV line from Mohave substation to Davis Substation, a single circuit 500-kV line from Mead substation to Davis substation, and a single circuit 500-kV line from Davis substation to Topock substation.

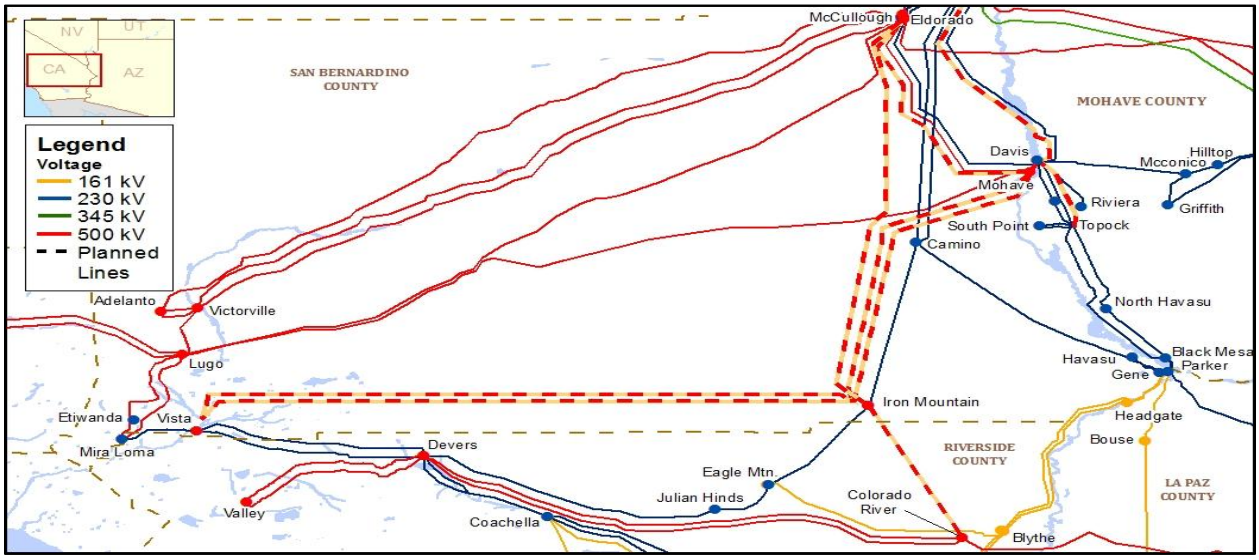

Figure 21 - S1C Alt 1 Sensitivity Configuration

Case Matrix

The following figure summarizes the 28 Post SMRT configurations that were tested and analyzed as part of the study.

Case #	Element A		Element B				Element C		Element D		Sensitivity	Name
1	A1		B1				C3		D1			A1-B1-C3-D1
2	A1		B1				C3			D2		A1-B1-C3-D2
3	A1		B1					C4	D1			A1-B1-C4-D1
4	A1		B1					C4		D2		A1-B1-C4-D2
5	A1			B2			C3		D1			A1-B2-C3-D1
6	A1			B2			C3			D2		A1-B2-C3-D2
7	A1			B2				C4	D1			A1-B2-C4-D1
8	A1			B2				C4		D2		A1-B2-C4-D2
9	A1				B3		C3		D1			A1-B3-C3-D1
10	A1				B3		C3			D2		A1-B3-C3-D2
11	A1				B3			C4	D1			A1-B3-C4-D1
12	A1				B3			C4		D2		A1-B3-C4-D2
13	A1					B4	C3		D1			A1-B4-C3-D1
14	A1					B4	C3			D2		A1-B4-C3-D2
15	A1					B4		C4	D1			A1-B4-C4-D1
16	A1					B4		C4		D2		A1-B4-C4-D2
17		A2	B1				C3		D1			A2-B1-C3-D1
18		A2	B1				C3			D2		A2-B1-C3-D2
19		A2	B1					C4	D1			A2-B1-C4-D1
20		A2	B1					C4		D2		A2-B1-C4-D2
21		A2			B3		C3		D1			A2-B3-C3-D1
22		A2			B3		C3			D2		A2-B3-C3-D2
23		A2			B3			C4	D1			A2-B3-C4-D1
24		A2			B3			C4		D2		A2-B3-C4-D2
25		A2				B4	C3		D1			A2-B4-C3-D1
26		A2				B4	C3			D2		A2-B4-C3-D2
27		A2				B4		C4	D1			A2-B4-C4-D1
28		A2				B4		C4		D2		A2-B4-C4-D2

Figure 22 - SMRT Project Case Matrix

The following figure summarizes the 10 Post SMRT sensitivity configurations that were tested and analyzed as part of the study.

Case #	Element A		Element B				Element C		Element D		Sensitivity	Name
29	A1					B4	C3		D1		S1A	A1-B4-C3-D1-S1A
30	A1					B4	C3		D1		S1B	A1-B4-C3-D1-S1B
31	A1					B4	C3		D1		S1B-ALT1	A1-B4-C3-D1-S1B-ALT1
32	A1					B4	C3		D1		S1C	A1-B4-C3-D1-S1C
33	A1					B4	C3		D1		S1C-ALT1	A1-B4-C3-D1-S1C-ALT1
34	A1					B4		C4	D1		S1A	A1-B4-C4-D1-S1A
35	A1					B4		C4	D1		S1B	A1-B4-C4-D1-S1B
36	A1					B4		C4	D1		S1B-ALT1	A1-B4-C4-D1-S1B-ALT1
37	A1					B4		C4	D1		S1C	A1-B4-C4-D1-S1C
38	A1					B4		C4	D1		S1C-ALT1	A1-B4-C4-D1-S1C-ALT1

Figure 23 - SMRT Sensitivity Case Matrix

Base Case

The Southwest Area Transmission (SWAT) 2019 Base case was chosen by the members of the SMRT Project as the Pre-SMRT base case for this study. The 2019 SWAT case was developed from the 2018 Heavy Summer WECC case. Members of SWAT modified the topology, loads, and resources of the case to represent what the planned transmission system would be in the year 2019. The members of SWAT include the utilities in New Mexico, El Paso, Texas, Arizona, Southern Nevada, and IID in Southern California but do not include any members of the CAISO. Therefore, transmission systems in the member areas were considered to be a good representation of what is planned to be in service in 2019. Additions, upgrades, or enhancements to the transmission system in the non-SWAT member areas may not be accurately reflected in this case. Element A of the SMRT Project has a planned in service date of 2014 and was modeled as in-service in the Pre-SMRT case.

Post SMRT Cases

The Post SMRT Project cases included one variation for each of the A, B, C, and D elements in various combinations as indicated in the case matrix. All of the Post Project SMRT cases used generation stressing in both non-simultaneous and simultaneous analysis. In the non-simultaneous analysis there was no generation displacement for maximum injection capabilities at each bus. Generation displacement was used in the Nevada, Arizona Palo Verde Hub, and Southern California areas for the simultaneous analysis. Generation displacement was conducted by adding a negative generator (load) at the generation collector buses. This load placement simulated the generation from the displaced generator not reaching the bulk transmission system. To simulate the delivery of generation to the various markets, displacement was distributed to the market areas as follows: Nevada received one-seventh of the generation displacement, the Palo Verde Hub received two-sevenths of the generation displacement, and California received four-sevenths of the generation displacement. California was broken down further in to percentages by utility with Southern California Edison (SCE) receiving 45 per cent of the generation displacement, Los Angeles Department of Water and Power (LADWP) receiving 30 per cent of the generation displacement, San Diego Gas & Electric (SDG&E) receiving 15 per cent of the generation displacement, and Pacific Gas & Electric (PG&E) receiving 10 per cent of the generation displacement.

Contingency Events for Study

Contingencies for the study consisted of all voltages 161-kV and above within the project and surrounding areas. These areas included Arizona, Imperial Irrigation District (IID), LADWP, Nevada, SDG&E, and SCE. N-1 events were recorded and reported as part of each analysis. A full listing of the contingencies for non-simultaneous and simultaneous injections is presented in the appendices to this report.

STUDY APPROACH

The SMRT participants determined that a two-step study procedure would be used for this high-level preliminary feasibility study. In the first step, a shift factor analysis was performed on individual injection buses one at a time to produce a Non-Simultaneous injection analysis. The results of the first step were then leveraged to analyze multiple buses on a simultaneous basis, again using shift factors to produce a Simultaneous injection analysis. The use of shift factors is described below along with the analyses comprising the two-step approach.

Shift Factor Analysis

Two types of "distribution factors" were used in this Study:

(1) An Injection Shift Factor – indicates the percentage of power injected at a particular bus (the "injection bus") that will flow over a given branch[9] (the "monitored branch") on the transmission grid.

(2) A Line Outage Distribution Factor - indicates the percentage of power flowing over a particular branch (the "contingency branch") that will divert upon its outage to the monitored branch.

The use of shift factor analyses satisfies two very important needs in this type of study:

(1) Calculation efficiency and

(2) The ability to directly compare flow impacts caused by individual power sources.

Calculation Efficiency

A preliminary feasibility study of the type undertaken here (evaluating 28 different system configurations, approximately 300 injection buses and 700 contingency branches) requires an extremely large number of calculations to screen the many options and permutations being considered. For example, the non-simultaneous portion of the Study required the equivalent of more than 16 million power flow simulations. Even today's powerful multi-core processors (capable of completing two power flow simulations per second) would take on the order of 100 days of uninterrupted computing to complete a comparable analysis.

Flow Impact Comparisons

A standard power flow solution requires that generation and load remain in balance. As a consequence, additional generation at a given location (the source) cannot be evaluated in isolation; there must be a corresponding change at another location (the sink), which will have its own impacts on the system. The sink can be represented as either an increased load or decreased generation. For a screening analysis, this rigid source-to-sink requirement causes several problems:

- The results are easily distorted by the sink assumption, especially if the chosen sink either: (i) has a greater flow impact on the monitored branches or (ii) offsets the flow

[9] Branch refers to either a transmission line or transformer.

impacts caused by the added source, thereby overstating the maximum injection capability.

- The requirement to continuously balance the sink against a variable source does not lend itself well to a “max-inject” type of analysis.
- An assumed sink can erroneously imply a preselected market.

The injection shift factors used in this study completely side-step these issues by separating the source and sink flow impacts.

Non-Simultaneous Injections

The non-simultaneous injections were performed at every bus above 69-kV within the Arizona control area, the IID control area, and selected buses from SDG&E and SCE. The maximum injections for each bus were calculated based on N-1 contingencies. The non-simultaneous injections determine the maximum additional generation that can be injected at a given bus without any generation displacement. The top five most limiting events are recorded with the maximum injection attainable before reaching a thermal overload within the monitored areas. In addition to the bus-by-bus detail, the maximum injection and its affect on the monitored WECC paths are recorded for each of these buses on a separate output. The results for the maximum non-simultaneous injections for the Pre-SMRT, Post SMRT, and Sensitivity cases are located in the appendices of this report.

Simultaneous Injections

The study scope listed 10 Renewable Energy Zones (REZ) as defined by the participants of the SMRT project within the study area. The 10 REZ were used to perform the simultaneous injection analysis. Each of the REZ had one or more “collector” buses as identified in the study scope.

Renewable Energy Zone	INJECTION STATION	
	Pre-SMRT Project	Post-SMRT Project
Zone 1	50% at Eldorado 500-kV & 50% at Mead 500-kV.	C3: (Same as pre-SMRT.)
		C4: (Same as pre-SMRT.)
Zone 2	100% at Davis 230-kV.	C3: 100% at Davis 230-kV.
		C4: 75% at Davis 500-kV & 25% at Davis 230-kV.
Zone 3	100% at Iron Mountain 230-kV.	Cases without Iron Mountain 500 kV: Same as pre-SMRT.
		Cases with Iron Mountain 500-kV Sensitivity: 75% at Iron Mountain 500-kV & 25% at Iron Mountain 230-kV.
Zone 4	100% at Parker 230-kV.	C3: 50% at Parker 500-kV & 50% at Parker 230-kV.
		C4: 75% at Parker 500-kV & 25% at Parker 230-kV.
Zone 5	50% at Blythe 161-kV & 50% at Bouse 161-kV.	C3: 75% at Colorado River/Midpoint 500-kV & 25% at Bouse 230-kV.
		C4: 50% at Colorado River/Midpoint 500-kV & 40% at Midpoint AZ 500-kV & 10% at Bouse 230-kV.
Zone 6	100% at Harcuvar 230-kV.	B1: (Same as pre-SMRT.)

		B2 through B4:75% at Harcuvar 500-kV & 25% at Harcuvar 230-kV.
Zone 7	100% at Imperial Valley 500-kV.	All: 100% at CTP 500-kV.
Zone 8	100% at North Gila 500-kV.	North Gila 500-kV
Zone 9	100% at Palo Verde 500-kV.	All: (Same as pre-SMRT.)
Zone 10	100% at Topock 230-kV.	C3: 100% at Topock 500-kV.
		C4: (Same as C3 above.)

Figure 24 - REZ Injection Buses

These collector buses were used to simulate the collection of renewable energy sources in the REZ. Maximum injections from the non-simultaneous analysis at the collector bus identified for each REZ were then further broken down into percentages from 10 per cent to 100 per cent in increments of 10 per cent. Per the study scope, generation dispatching was used during the simultaneous analysis. The amount of generation dispatch agreed to by the members of the SMRT project was listed in the study scope as being one-seventh for Nevada, two-sevenths for the Palo Verde Hub area, and four-sevenths for the California entities. The generation dispatch was accomplished using negative generators (loads) at generation collector buses in the respective areas. The 10 REZ were simultaneously injected with an equal percentage of maximum injection capability. The case was then processed to determine if any thermal overloads occurred in the study area. If no overloads were present then the injection percentage was incremented by 10 per cent until an overload was detected.

System Performance Measurements

Shift Factor Analysis does not measure or determine voltages within the system nor does it use voltages to measure or determine flow on lines or across transformers. Shift Factor Analysis measures and determines performance based on thermal loading of the elements by using impedances. Therefore, system performance was measured against continuous ratings of the elements for N-0 conditions and emergency ratings of the elements for N-1 conditions. Once the continuous or emergency ratings of an element were exceeded further injections stopped.

In addition to the thermal loading measurements, certain WECC paths were monitored to determine if the injections caused overloads. However, exceeding the path ratings was not considered a stopping event for the injection testing. The WECC paths that were monitored as part of the study were:

PATH: DESCRIPTION

26: NORTHERN - SOUTHERN CALIFORNIA
27: IPP DC LINE
42: IID - SCE
46: WEST OF COLORADO RIVER (WOR)
49: EAST OF COLORADO RIVER (EOR)
59: WALC BLYTHE - SCE BLYTHE 161 KV
61: LUGO - VICTORVILLE 500 KV LINE
62: ELDORADO - MCCULLOUGH 500 KV

63: PERKINS - MEAD - MARKETPLACE 500
65: PACIFIC DC INTERTIE (PDCI)
66: COI
81: CENTENNIAL

PSLF Verification Process

Per the study scope, Positive Sequence Load Flow (PSLF) was used to verify the maximum injection amounts from the non-simultaneous results of the shift factor analysis for the Base case. The following table lists the shift factor analysis maximum injection amount by REZ.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	2182
	19038	Mead	500	14	191	2320
2	19022	Davis	230	14	191	349
3	25405	Iron Mtn.	230	24	248	113
4	19042	Parker	230	14	191	708
5	19020	Blythe	161	14	191	359
	19046	Bouse	161	14	191	205
6	19204	Harcuvar	230	14	191	495
7	22360	Imperial Valley	500	22	227	1416
8	22536	N. Gila	500	22	227	1180
9	15021	Palo Verde	500	14	910	2344
10	19320	Topock	230	14	191	228

Table 4 - Shift Factor Analysis Maximum REZ Injections (Pre-SMRT)

The maximum injection amounts were modeled in PSLF at the injection buses listed previously in Figure 24. Generation was displaced to the three market areas per the study plan with one-seventh being displaced in Nevada, two-sevenths being displaced in Arizona, and four-sevenths being displaced in Southern California. N-1 contingencies were performed to determine thermal overloads and the level of overloads. The overloads from the PSLF processed cases were compared to the overloads from the Shift Factor Analysis processed case to determine accuracies. All injection amounts showed accuracies of greater than 90 per cent. The results of the PSLF verification are located in the appendices of this report.

ANALYSIS RESULTS

Each of the 39 study cases, (Base case, 28 post SMRT, and 10 Sensitivity cases) was analyzed to determine thermal overloads caused by the injections, maximum injection capability, and path rating overloads for non-simultaneous and simultaneous injections. Maps depicting the different case configurations can be found in the appendices of this report. Following is a summary of the analysis for each individual case.

Base Case

2019 SWAT Case with Element A

Non-Simultaneous Results

The non-simultaneous results for the pre-SMRT case indicated that the largest maximum injection collector bus for the REZ occurred at the Palo Verde 500-kV substation and was 2,344MW. The total injection at the 10 REZ collector buses was 11,899MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	2182
	19038	Mead	500	14	191	2320
2	19022	Davis	230	14	191	349
3	25405	Iron Mtn.	230	24	248	113
4	19042	Parker	230	14	191	708
5	19020	Blythe	161	14	191	359
	19046	Bouse	161	14	191	205
6	19204	Harcuvar	230	14	191	495
7	22360	Imperial Valley	500	22	227	1416
8	22536	N. Gila	500	22	227	1180
9	15021	Palo Verde	500	14	910	2344
10	19320	Topock	230	14	191	228
Total Injection Amount						11899

Table 5 - Base Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the pre-SMRT case indicated that the overloads began to occur on transmission lines in the study area when tested at the 70 per cent level. The 70 per cent level represented 8,329MW of injection within the 10 REZ. The first limiting element within the study area is the Ramon – Mirage 230-kV transmission line. The initial overload occurs at 8,016MW of injection which represents approximately the 67 per cent level. The simultaneous results indicated that at the 70 per cent level two WECC paths were overloaded. Path 46, West of River, was overloaded by 53.2MW and

Path 61, Lugo – Victorville 500-kV Line, was overloaded by 47.9MW. Both overloads at the 70 per cent level were within operating limits at the 67 per cent level.

Post SMRT Cases

A1-B1-C3-D1

Non-Simultaneous Results

The non-simultaneous results for the A1-B1-C3-D1 case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 4,059MW. The total injection at the 10 REZ collector buses was 38,790MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4059
	19038	Mead	500	14	191	4044
2	19022	Davis	230	14	191	973
3	25405	Iron Mtn.	230	24	248	479
4	19042	Parker	230	14	191	2853
	19910	Parker	500	14	191	3661
5	24900	Colorado River	500	24	800	3502
	19908	Bouse	230	14	191	2623
6	19204	Harcuvar	230	14	191	2325
7	83026	CTP 500	500	14	800	3368
8	22536	N. Gila	500	22	227	3478
9	15021	Palo Verde	500	14	910	3642
10	19912	Topock	500	14	191	3783
Total Injection Amount						38790

Table 6 - A1-B1-C3-D1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B1-C3-D1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 19,399MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 17,373MW which represents approximately the 45 per cent level and the initial overload for N-1 conditions occurs at 17,253MW of injection which represents approximately the 44 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 1,818MW. This overload occurs at 17,129MW of injection.

A1-B1-C3-D2

Non-Simultaneous Results

The non-simultaneous results for the A1-B1-C3-D2 case indicated that the largest maximum injection collector bus for the REZ occurred at the Mead 500-kV substation and was 4,061MW. The total injection at the 10 REZ collector buses was 39,428MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4000
	19038	Mead	500	14	191	4061
2	19022	Davis	230	14	191	959
3	25405	Iron Mtn.	230	24	248	458
4	19042	Parker	230	14	191	2930
	19910	Parker	500	14	191	3756
5	24900	Colorado River	500	24	800	3585
	19908	Bouse	230	14	191	2647
6	19204	Harcuvar	230	14	191	2334
7	83026	CTP 500	500	14	800	3479
8	22536	N. Gila	500	22	227	3586
9	15021	Palo Verde	500	14	910	3744
10	19912	Topock	500	14	191	3889
Total Injection Amount						39428

Table 7 - A1-B1-C3-D2 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B1-C3-D2 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 19,716MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 17,683MW which represents approximately the 45 per cent level and the initial overload for N-1 conditions occurs at 17,051MW of injection which represents approximately the 43 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 1,309MW. This overload occurs at 17,999MW of injection.

A1-B1-C4-D1

Non-Simultaneous Results

The non-simultaneous results for the A1-B1-C4-D1 case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 4,170MW. The total injection at the 10 REZ collector buses was 46,685MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4170
	19038	Mead	500	14	191	4160
2	19913	Davis	500	14	191	3979
	19022	Davis	230	14	191	1355
3	25405	Iron Mtn.	230	24	248	516
4	19042	Parker	230	14	191	2528
	19910	Parker	500	14	191	3788
5	24900	Colorado River	500	24	800	3615
	19909	Mid Point AZ	500	14	191	3698
	19908	Bouse	230	14	191	2001
6	19204	Harcuvar	230	14	191	2070
7	83026	CTP 500	500	14	800	3499
8	22536	N. Gila	500	22	227	3623
9	15021	Palo Verde	500	14	910	3762
10	19912	Topock	500	14	191	3921
Total Injection Amount						46685

Table 8 - A1-B1-C4-D1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B1-C4-D1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 40 per cent level. The 40 per cent level represented 18,674MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 16,792MW which represents approximately the 36 per cent level and the initial overload for N-1 conditions occurs at 17,121MW of injection which represents approximately the 37 per cent level. The simultaneous results indicated that at the 40 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 1,487MW. This overload occurs at 16,848MW of injection.

A1-B1-C4-D2

Non-Simultaneous Results

The non-simultaneous results for the A1-B1-C4-D2 case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 4,167MW. The total injection at the 10 REZ collector buses was 46,776MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus No.	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4167
	19038	Mead	500	14	191	4157
2	19913	Davis	500	14	191	3978
	19022	Davis	230	14	191	1350
3	25405	Iron Mtn.	230	24	248	517
4	19042	Parker	230	14	191	2596
	19910	Parker	500	14	191	3786
5	24900	Colorado River	500	24	800	3607
	19909	Mid Point AZ	500	14	191	3697
	19908	Bouse	230	14	191	1998
6	19204	Harcuvar	230	14	191	2087
7	83026	CTP 500	500	14	800	3516
8	22536	N. Gila	500	22	227	3636
9	15021	Palo Verde	500	14	910	3761
10	19912	Topock	500	14	191	3923
Total Injection Amount						46776

Table 9 - A1-B1-C4-D2 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B1-C4-D2 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 40 per cent level. The 40 per cent level represented 18,709MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 16,919MW which represents approximately the 36 per cent level and the initial overload for N-1 conditions occurs at 17,098MW of injection which represents approximately the 37 per cent level. The simultaneous results indicated that at the 40 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 1,512MW. This overload occurs at 16,852MW of injection.

A1-B2-C3-D1

Non-Simultaneous Results

The non-simultaneous results for the A1-B2-C3-D1 case indicated that the largest maximum injection collector bus for the REZ occurred at the Topock 500-kV substation and was 3,899MW. The total injection at the 10 REZ collector buses was 40,153MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3831
	19038	Mead	500	14	191	3890
2	19022	Davis	230	14	191	952
3	25405	Iron Mtn.	230	24	248	450
4	19042	Parker	230	14	191	2644
	19910	Parker	500	14	191	3786
5	24900	Colorado River	500	24	800	3604
	19908	Bouse	230	14	191	2419
6	83005	Harcuvar	500	14	191	1844
	19204	Harcuvar	230	14	191	1976
7	83026	CTP 500	500	14	800	3480
8	22536	N. Gila	500	22	227	3596
9	15021	Palo Verde	500	14	910	3782
10	19912	Topock	500	14	191	3899
Total Injection Amount						40153

Table 10 - A1-B2-C3-D1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B2-C3-D1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 20,079MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 17,234MW which represents approximately the 43 per cent level and the initial overload for N-1 conditions occurs at 17,218MW of injection which represents approximately the 43 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 2,092MW. This overload occurs at 17,422MW of injection.

A1-B2-C3-D2

Non-Simultaneous Results

The non-simultaneous results for the A1-B2-C3-D2 case indicated that the largest maximum injection collector bus for the REZ occurred at the Mead 500-kV substation and was 3,862MW. The total injection at the 10 REZ collector buses was 40,150MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3804
	19038	Mead	500	14	191	3862
2	19022	Davis	230	14	191	942
3	25405	Iron Mtn.	230	24	248	451
4	19042	Parker	230	14	191	2750
	19910	Parker	500	14	191	3780
5	24900	Colorado River	500	24	800	3594
	19908	Bouse	230	14	191	2452
6	83005	Harcuvar	500	14	191	1808
	19204	Harcuvar	230	14	191	1992
7	83026	CTP 500	500	14	800	3503
8	22536	N. Gila	500	22	227	3616
9	15021	Palo Verde	500	14	910	3791
10	19912	Topock	500	14	191	3805
Total Injection Amount						40150

Table 11 - A1-B2-C3-D2 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B2-C3-D2 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 20,079MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 17,244MW which represents approximately the 43 per cent level and the initial overload for N-1 conditions occurs at 17,157MW of injection which represents approximately the 43 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 1,458MW. This overload occurs at 18,150MW of injection.

A1-B2-C4-D1

Non-Simultaneous Results

The non-simultaneous results for the A1-B2-C4-D1 case indicated that the largest maximum injection collector bus for the REZ occurred at the Mead 500-kV substation and was 4,196MW. The total injection at the 10 REZ collector buses was 48,821MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4106
	19038	Mead	500	14	191	4196
2	19913	Davis	500	14	191	4016
	19022	Davis	230	14	191	1346
3	25405	Iron Mtn.	230	24	248	508
4	19042	Parker	230	14	191	2527
	19910	Parker	500	14	191	3828
5	24900	Colorado River	500	24	800	3602
	19909	Mid Point AZ	500	14	191	3776
	19908	Bouse	230	14	191	1973
6	83005	Harcuvar	500	14	191	1822
	19204	Harcuvar	230	14	191	2193
7	83026	CTP 500	500	14	800	3521
8	22536	N. Gila	500	22	227	3654
9	15021	Palo Verde	500	14	910	3792
10	19912	Topock	500	14	191	3961
Total Injection Amount						48821

Table 12 - A1-B2-C4-D1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B2-C4-D2 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 40 per cent level. The 40 per cent level represented 19,529MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 16,290MW which represents approximately the 33 per cent level and the initial overload for N-1 conditions occurs at 16,982MW of injection which represents approximately the 35 per cent level. The simultaneous results indicated that at the 40 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 1,939MW. This overload occurs at 17,111MW of injection.

A1-B2-C4-D2

Non-Simultaneous Results

The non-simultaneous results for the A1-B2-C4-D2 case indicated that the largest maximum injection collector bus for the REZ occurred at the Mead 500-kV substation and was 4,189MW. The total injection at the 10 REZ collector buses was 48,821MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4074
	19038	Mead	500	14	191	4189
2	19913	Davis	500	14	191	4022
	19022	Davis	230	14	191	1342
3	25405	Iron Mtn.	230	24	248	509
4	19042	Parker	230	14	191	2603
	19910	Parker	500	14	191	3833
5	24900	Colorado River	500	24	800	3595
	19909	Mid Point AZ	500	14	191	3785
	19908	Bouse	230	14	191	1966
6	83005	Harcuvar	500	14	191	1804
	19204	Harcuvar	230	14	191	2201
7	83026	CTP 500	500	14	800	3531
8	22536	N. Gila	500	22	227	3674
9	15021	Palo Verde	500	14	910	3804
10	19912	Topock	500	14	191	3968
Total Injection Amount						48900

Table 13 - A1-B2-C4-D2 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B2-C4-D2 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 40 per cent level. The 40 per cent level represented 19,562MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 16,022MW which represents approximately the 33 per cent level and the initial overload for N-1 conditions occurs at 16,907MW of injection which represents approximately the 35 per cent level. The simultaneous results indicated that at the 40 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 1,944MW. This overload occurs at 17,134MW of injection.

A1-B3-C3-D1

Non-Simultaneous Results

The non-simultaneous results for the A1-B3-C3-D1 case indicated that the largest maximum injection collector bus for the REZ occurred at the Topock 500-kV substation and was 3,947MW. The total injection at the 10 REZ collector buses was 48,821MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3856
	19038	Mead	500	14	191	3915
2	19022	Davis	230	14	191	985
3	25405	Iron Mtn.	230	24	248	497
4	19042	Parker	230	14	191	2710
	19910	Parker	500	14	191	3800
5	24900	Colorado River	500	24	800	3606
	19908	Bouse	230	14	191	2299
6	83005	Harcuvar	500	14	191	2739
	19204	Harcuvar	230	14	191	2558
7	83026	CTP 500	500	14	800	3502
8	22536	N. Gila	500	22	227	3609
9	15021	Palo Verde	500	14	910	3804
10	19912	Topock	500	14	191	3947
Total Injection Amount						41827

Table 14 - A1-B3-C3-D1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B3-C3-D1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 20,916MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 17,442MW which represents approximately the 42 per cent level and the initial overload for N-1 conditions occurs at 17,466MW of injection which represents approximately the 42 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 2,290MW. This overload occurs at 17,923MW of injection.

A1-B3-C3-D2

Non-Simultaneous Results

The non-simultaneous results for the A1-B3-C3-D2 case indicated that the largest maximum injection collector bus for the REZ occurred at the Topock 500-kV substation and was 3,949MW. The total injection at the 10 REZ collector buses was 41,921MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3833
	19038	Mead	500	14	191	3891
2	19022	Davis	230	14	191	975
3	25405	Iron Mtn.	230	24	248	500
4	19042	Parker	230	14	191	2815
	19910	Parker	500	14	191	3793
5	24900	Colorado River	500	24	800	3599
	19908	Bouse	230	14	191	2339
6	83005	Harcuvar	500	14	191	2716
	19204	Harcuvar	230	14	191	2567
7	83026	CTP 500	500	14	800	3522
8	22536	N. Gila	500	22	227	3620
9	15021	Palo Verde	500	14	910	3802
10	19912	Topock	500	14	191	3949
Total Injection Amount						41921

Table 15 - A1-B3-C3-D2 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B3-C3-D2 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 20,961MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 17,479MW which represents approximately the 42 per cent level and the initial overload for N-1 conditions occurs at 17,381MW of injection which represents approximately the 41 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 2,313MW. This overload occurs at 17,936MW of injection.

A1-B3-C4-D1

Non-Simultaneous Results

The non-simultaneous results for the A1-B3-C4-D1 case indicated that the largest maximum injection collector bus for the REZ occurred at the Mead 500-kV substation and was 4,185MW. The total injection at the 10 REZ collector buses was 50,213MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4122
	19038	Mead	500	14	191	4185
2	19913	Davis	500	14	191	3995
	19022	Davis	230	14	191	1365
3	25405	Iron Mtn.	230	24	248	501
4	19042	Parker	230	14	191	2503
	19910	Parker	500	14	191	3820
5	24900	Colorado River	500	24	800	3606
	19909	Mid Point AZ	500	14	191	3765
	19908	Bouse	230	14	191	1984
6	83005	Harcuvar	500	14	191	2900
	19204	Harcuvar	230	14	191	2563
7	83026	CTP 500	500	14	800	3521
8	22536	N. Gila	500	22	227	3648
9	15021	Palo Verde	500	14	910	3800
10	19912	Topock	500	14	191	3935
Total Injection Amount						50213

Table 16 - A1-B3-C4-D1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B3-C4-D1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 40 per cent level. The 40 per cent level represented 20,083MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 16,381MW which represents approximately the 33 per cent level and the initial overload for N-1 conditions occurs at 17,112MW of injection which represents approximately the 34 per cent level. The simultaneous results indicated that at the 40 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 2,230MW. This overload occurs at 17,275MW of injection.

A1-B3-C4-D2

Non-Simultaneous Results

The non-simultaneous results for the A1-B3-C4-D2 case indicated that the largest maximum injection collector bus for the REZ occurred at the Mead 500-kV substation and was 4,190MW. The total injection at the 10 REZ collector buses was 50,307MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4090
	19038	Mead	500	14	191	4190
2	19913	Davis	500	14	191	4003
	19022	Davis	230	14	191	1361
3	25405	Iron Mtn.	230	24	248	503
4	19042	Parker	230	14	191	2580
	19910	Parker	500	14	191	3826
5	24900	Colorado River	500	24	800	3597
	19909	Mid Point AZ	500	14	191	3772
	19908	Bouse	230	14	191	1979
6	83005	Harcuvar	500	14	191	2884
	19204	Harcuvar	230	14	191	2571
7	83026	CTP 500	500	14	800	3536
8	22536	N. Gila	500	22	227	3663
9	15021	Palo Verde	500	14	910	3811
10	19912	Topock	500	14	191	3941
Total Injection Amount						50307

Table 17 - A1-B3-C4-D2 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B3-C4-D2 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 40 per cent level. The 40 per cent level represented 20,123MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 16,134MW which represents approximately the 32 per cent level and the initial overload for N-1 conditions occurs at 17,039MW of injection which represents approximately the 34 per cent level. The simultaneous results indicated that at the 40 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 2,242MW. This overload occurs at 17,297MW of injection.

A1-B4-C3-D1

Non-Simultaneous Results

The non-simultaneous results for the A1-B4-C3-D1 case indicated that the largest maximum injection collector bus for the REZ occurred at the Mead 500-kV substation and was 3,994MW. The total injection at the 10 REZ collector buses was 42,190MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3932
	19038	Mead	500	14	191	3994
2	19022	Davis	230	14	191	933
3	25405	Iron Mtn.	230	24	248	514
4	19042	Parker	230	14	191	2985
	19910	Parker	500	14	191	3788
5	24900	Colorado River	500	24	800	3610
	19908	Bouse	230	14	191	2478
6	83005	Harcuvar	500	14	191	2434
	19204	Harcuvar	230	14	191	2746
7	83026	CTP 500	500	14	800	3493
8	22536	N. Gila	500	22	227	3591
9	15021	Palo Verde	500	14	910	3772
10	19912	Topock	500	14	191	3920
Total Injection Amount						42190

Table 18 - A1-B4-C3-D1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B4-C3-D1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 21,098MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 17,742MW which represents approximately the 42 per cent level and the initial overload for N-1 conditions occurs at 17,577MW of injection which represents approximately the 42 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 2,368MW. This overload occurs at 17,992MW of injection.

A1-B4-C3-D2

Non-Simultaneous Results

The non-simultaneous results for the A1-B4-C3-D2 case indicated that the largest maximum injection collector bus for the REZ occurred at the Mead 500-kV substation and was 3.975MW. The total injection at the 10 REZ collector buses was 42,179MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3914
	19038	Mead	500	14	191	3975
2	19022	Davis	230	14	191	922
3	25405	Iron Mtn.	230	24	248	516
4	19042	Parker	230	14	191	3081
	19910	Parker	500	14	191	3782
5	24900	Colorado River	500	24	800	3602
	19908	Bouse	230	14	191	2508
6	83005	Harcuvar	500	14	191	2399
	19204	Harcuvar	230	14	191	2768
7	83026	CTP 500	500	14	800	3513
8	22536	N. Gila	500	22	227	3602
9	15021	Palo Verde	500	14	910	3778
10	19912	Topock	500	14	191	3819
Total Injection Amount						42179

Table 19 - A1-B4-C3-D2 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B4-C3-D2 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 21,091MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 18,022MW which represents approximately the 43 per cent level and the initial overload for N-1 conditions occurs at 17,508MW of injection which represents approximately the 42 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 2,384MW. This overload occurs at 17,968MW of injection.

A1-B4-C4-D1

Non-Simultaneous Results

The non-simultaneous results for the A1-B4-C4-D1 case indicated that the largest maximum injection collector bus for the REZ occurred at the Mead 500-kV substation and was 3,585MW. The total injection at the 10 REZ collector buses was 45,219MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3583
	19038	Mead	500	14	191	3585
2	19913	Davis	500	14	191	3461
	19022	Davis	230	14	191	1374
3	25405	Iron Mtn.	230	24	248	568
4	19042	Parker	230	14	191	2581
	19910	Parker	500	14	191	3336
5	24900	Colorado River	500	24	800	3208
	19909	Mid Point AZ	500	14	191	3262
	19908	Bouse	230	14	191	1953
6	83005	Harcuvar	500	14	191	2513
	19204	Harcuvar	230	14	191	2694
7	83026	CTP 500	500	14	800	3140
8	22536	N. Gila	500	22	227	3216
9	15021	Palo Verde	500	14	910	3328
10	19912	Topock	500	14	191	3417
Total Injection Amount						45219

Table 20 - A1-B4-C4-D1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B4-C4-D1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 40 per cent level. The 40 per cent level represented 18,090MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 16,253MW which represents approximately the 36 per cent level and the initial overload for N-1 conditions occurs at 16,851MW of injection which represents approximately the 37 per cent level. The simultaneous results indicated that at the 40 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 1,303MW. This overload occurs at 16,521MW of injection.

A1-B4-C4-D2

Non-Simultaneous Results

The non-simultaneous results for the A1-B4-C4-D2 case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 4,165MW. The total injection at the 10 REZ collector buses was 49,893MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4165
	19038	Mead	500	14	191	4160
2	19913	Davis	500	14	191	3975
	19022	Davis	230	14	191	1330
3	25405	Iron Mtn.	230	24	248	519
4	19042	Parker	230	14	191	2668
	19910	Parker	500	14	191	3795
5	24900	Colorado River	500	24	800	3613
	19909	Mid Point AZ	500	14	191	3688
	19908	Bouse	230	14	191	1967
6	83005	Harcuvar	500	14	191	2505
	19204	Harcuvar	230	14	191	2663
7	83026	CTP 500	500	14	800	3520
8	22536	N. Gila	500	22	227	3632
9	15021	Palo Verde	500	14	910	3780
10	19912	Topock	500	14	191	3913
Total Injection Amount						49893

Table 21 - A1-B4-C4-D2 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B4-C4-D2 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 40 per cent level. The 40 per cent level represented 19,959MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 16,966MW which represents approximately the 34 per cent level and the initial overload for N-1 conditions occurs at 17,228MW of injection which represents approximately the 35 per cent level. The simultaneous results indicated that at the 40 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 2,193MW. This overload occurs at 17,208MW of injection.

A2-B1-C3-D1

Non-Simultaneous Results

The non-simultaneous results for the A2-B1-C3-D1 case indicated that the largest maximum injection collector bus for the REZ occurred at the Mead 500-kV substation and was 4,047MW. The total injection at the 10 REZ collector buses was 39,170MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3985
	19038	Mead	500	14	191	4047
2	19022	Davis	230	14	191	965
3	25405	Iron Mtn.	230	24	248	458
4	19042	Parker	230	14	191	2806
	19910	Parker	500	14	191	3767
5	24900	Colorado River	500	24	800	3599
	19908	Bouse	230	14	191	2594
6	19204	Harcuvar	230	14	191	2254
7	83026	CTP 500	500	14	800	3465
8	22536	N. Gila	500	22	227	3585
9	15021	Palo Verde	500	14	910	3746
10	19912	Topock	500	14	191	3899
Total Injection Amount						39170

Table 22 - A2-B1-C3-D1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A2-B1-C3-D1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 19,586MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 17,337MW which represents approximately the 44 per cent level and the initial overload for N-1 conditions occurs at 17,140MW of injection which represents approximately the 44 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 1,800MW. This overload occurs at 15,800MW of injection.

A2-B1-C3-D2

Non-Simultaneous Results

The non-simultaneous results for the A2-B1-C3-D2 case indicated that the largest maximum injection collector bus for the REZ occurred at the Mead 500-kV substation and was 4,035MW. The total injection at the 10 REZ collector buses was 39,329MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3975
	19038	Mead	500	14	191	4035
2	19022	Davis	230	14	191	954
3	25405	Iron Mtn.	230	24	248	459
4	19042	Parker	230	14	191	2902
	19910	Parker	500	14	191	3761
5	24900	Colorado River	500	24	800	3588
	19908	Bouse	230	14	191	2641
6	19204	Harcuvar	230	14	191	2293
7	83026	CTP 500	500	14	800	3486
8	22536	N. Gila	500	22	227	3594
9	15021	Palo Verde	500	14	910	3746
10	19912	Topock	500	14	191	3895
Total Injection Amount						39329

Table 23 - A2-B1-C3-D2 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A2-B1-C3-D2 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 19,668MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 17,554MW which represents approximately the 45 per cent level and the initial overload for N-1 conditions occurs at 17,114MW of injection which represents approximately the 44 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 1,260MW. This overload occurs at 16,438MW of injection.

A2-B1-C4-D1

Non-Simultaneous Results

The non-simultaneous results for the A2-B1-C4-D1 case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 4,170MW. The total injection at the 10 REZ collector buses was 46,643MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4170
	19038	Mead	500	14	191	4160
2	19913	Davis	500	14	191	3977
	19022	Davis	230	14	191	1355
3	25405	Iron Mtn.	230	24	248	517
4	19042	Parker	230	14	191	2527
	19910	Parker	500	14	191	3788
5	24900	Colorado River	500	24	800	3616
	19909	Mid Point AZ	500	14	191	3694
	19908	Bouse	230	14	191	1991
6	19204	Harcuvar	230	14	191	2042
7	83026	CTP 500	500	14	800	3501
8	22536	N. Gila	500	22	227	3628
9	15021	Palo Verde	500	14	910	3756
10	19912	Topock	500	14	191	3921
Total Injection Amount						46643

Table 24 - A2-B1-C4-D1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A2-B1-C4-D1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 40 per cent level. The 40 per cent level represented 18,657MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 16,727MW which represents approximately the 36 per cent level and the initial overload for N-1 conditions occurs at 17,087MW of injection which represents approximately the 37 per cent level. The simultaneous results indicated that at the 40 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 1,481MW. This overload occurs at 16,839MW of injection.

A2-B1-C4-D2

Non-Simultaneous Results

The non-simultaneous results for the A2-B1-C4-D2 case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 4,173MW. The total injection at the 10 REZ collector buses was 46,763MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4173
	19038	Mead	500	14	191	4163
2	19913	Davis	500	14	191	3976
	19022	Davis	230	14	191	1350
3	25405	Iron Mtn.	230	24	248	520
4	19042	Parker	230	14	191	2597
	19910	Parker	500	14	191	3786
5	24900	Colorado River	500	24	800	3609
	19909	Mid Point AZ	500	14	191	3694
	19908	Bouse	230	14	191	1991
6	19204	Harcuvar	230	14	191	2066
7	83026	CTP 500	500	14	800	3518
8	22536	N. Gila	500	22	227	3640
9	15021	Palo Verde	500	14	910	3757
10	19912	Topock	500	14	191	3923
Total Injection Amount						46763

Table 25 - A2-B1-C4-D2 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A2-B1-C4-D2 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 40 per cent level. The 40 per cent level represented 18,705MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 16,833MW which represents approximately the 36 per cent level and the initial overload for N-1 conditions occurs at 17,068MW of injection which represents approximately the 36 per cent level. The simultaneous results indicated that at the 40 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 1,503MW. This overload occurs at 16,858MW of injection.

A2-B3-C3-D1

Non-Simultaneous Results

The non-simultaneous results for the A2-B3-C3-D1 case indicated that the largest maximum injection collector bus for the REZ occurred at the Topock 500-kV substation and was 3,946MW. The total injection at the 10 REZ collector buses was 41,913MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3870
	19038	Mead	500	14	191	3929
2	19022	Davis	230	14	191	983
3	25405	Iron Mtn.	230	24	248	499
4	19042	Parker	230	14	191	2712
	19910	Parker	500	14	191	3791
5	24900	Colorado River	500	24	800	3604
	19908	Bouse	230	14	191	2231
6	83005	Harcuvar	500	14	191	2908
	19204	Harcuvar	230	14	191	2509
7	83026	CTP 500	500	14	800	3508
8	22536	N. Gila	500	22	227	3619
9	15021	Palo Verde	500	14	910	3804
10	19912	Topock	500	14	191	3946
Total Injection Amount						41913

Table 26 - A2-B3-C3-D1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A2-B3-C3-D1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 20,958MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 17,181MW which represents approximately the 41 per cent level and the initial overload for N-1 conditions occurs at 17,335MW of injection which represents approximately the 41 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 2,319MW. This overload occurs at 17,927MW of injection.

A2-B3-C3-D2

Non-Simultaneous Results

The non-simultaneous results for the A2-B3-C3-D2 case indicated that the largest maximum injection collector bus for the REZ occurred at the Topock 500-kV substation and was 3,943MW. The total injection at the 10 REZ collector buses was 42,000MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3842
	19038	Mead	500	14	191	3901
2	19022	Davis	230	14	191	974
3	25405	Iron Mtn.	230	24	248	501
4	19042	Parker	230	14	191	2821
	19910	Parker	500	14	191	3785
5	24900	Colorado River	500	24	800	3595
	19908	Bouse	230	14	191	2285
6	83005	Harcuvar	500	14	191	2869
	19204	Harcuvar	230	14	191	2524
7	83026	CTP 500	500	14	800	3526
8	22536	N. Gila	500	22	227	3631
9	15021	Palo Verde	500	14	910	3803
10	19912	Topock	500	14	191	3943
Total Injection Amount						42000

Table 27 - A2-B3-C3-D2 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A2-B3-C3-D2 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 21,004MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 17,125MW which represents approximately the 41 per cent level and the initial overload for N-1 conditions occurs at 17,234MW of injection which represents approximately the 41 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 2,349MW. This overload occurs at 17,934MW of injection.

A2-B3-C4-D1

Non-Simultaneous Results

The non-simultaneous results for the A2-B3-C4-D1 case indicated that the largest maximum injection collector bus for the REZ occurred at the Mead 500-kV substation and was 4,185MW. The total injection at the 10 REZ collector buses was 50,315MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4137
	19038	Mead	500	14	191	4185
2	19913	Davis	500	14	191	3996
	19022	Davis	230	14	191	1364
3	25405	Iron Mtn.	230	24	248	503
4	19042	Parker	230	14	191	2507
	19910	Parker	500	14	191	3817
5	24900	Colorado River	500	24	800	3605
	19909	Mid Point AZ	500	14	191	3759
	19908	Bouse	230	14	191	1965
6	83005	Harcuvar	500	14	191	3045
	19204	Harcuvar	230	14	191	2527
7	83026	CTP 500	500	14	800	3523
8	22536	N. Gila	500	22	227	3650
9	15021	Palo Verde	500	14	910	3801
10	19912	Topock	500	14	191	3931
Total Injection Amount						50315

Table 28 - A2-B3-C4-D1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A2-B3-C4-D1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 40 per cent level. The 40 per cent level represented 20,124MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 16,247MW which represents approximately the 32 per cent level and the initial overload for N-1 conditions occurs at 17,042MW of injection which represents approximately the 34 per cent level. The simultaneous results indicated that at the 40 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 2,273MW. This overload occurs at 17,264MW of injection.

A2-B3-C4-D2

Non-Simultaneous Results

The non-simultaneous results for the A2-B3-C4-D2 case indicated that the largest maximum injection collector bus for the REZ occurred at the Mead 500-kV substation and was 4,192MW. The total injection at the 10 REZ collector buses was 50,401MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4102
	19038	Mead	500	14	191	4192
2	19913	Davis	500	14	191	4003
	19022	Davis	230	14	191	1360
3	25405	Iron Mtn.	230	24	248	505
4	19042	Parker	230	14	191	2586
	19910	Parker	500	14	191	3820
5	24900	Colorado River	500	24	800	3599
	19909	Mid Point AZ	500	14	191	3764
	19908	Bouse	230	14	191	1964
6	83005	Harcuvar	500	14	191	3017
	19204	Harcuvar	230	14	191	2538
7	83026	CTP 500	500	14	800	3535
8	22536	N. Gila	500	22	227	3665
9	15021	Palo Verde	500	14	910	3812
10	19912	Topock	500	14	191	3939
Total Injection Amount						50401

Table 29 - A2-B3-C4-D2 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A2-B3-C4-D2 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 40 per cent level. The 40 per cent level represented 20,162MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 15,968MW which represents approximately the 32 per cent level and the initial overload for N-1 conditions occurs at 17,034MW of injection which represents approximately the 34 per cent level. The simultaneous results indicated that at the 40 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 2,267MW. This overload occurs at 17,303MW of injection.

A2-B4-C3-D1

Non-Simultaneous Results

The non-simultaneous results for the A2-B4-C3-D1 case indicated that the largest maximum injection collector bus for the REZ occurred at the Mead 500-kV substation and was 3,997MW. The total injection at the 10 REZ collector buses was 42,165MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3935
	19038	Mead	500	14	191	3997
2	19022	Davis	230	14	191	942
3	25405	Iron Mtn.	230	24	248	513
4	19042	Parker	230	14	191	2972
	19910	Parker	500	14	191	3787
5	24900	Colorado River	500	24	800	3610
	19908	Bouse	230	14	191	2471
6	83005	Harcuvar	500	14	191	2409
	19204	Harcuvar	230	14	191	2722
7	83026	CTP 500	500	14	800	3498
8	22536	N. Gila	500	22	227	3599
9	15021	Palo Verde	500	14	910	3775
10	19912	Topock	500	14	191	3935
Total Injection Amount						42165

Table 30 - A2-B4-C3-D1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A2-B4-C3-D1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 21,084MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 17,476MW which represents approximately the 41 per cent level and the initial overload for N-1 conditions occurs at 17,431MW of injection which represents approximately the 41 per cent level. The simultaneous results indicated that at the 40 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 2,389MW. This overload occurs at 17,957MW of injection.

A2-B4-C3-D2

Non-Simultaneous Results

The non-simultaneous results for the A2-B4-C3-D2 case indicated that the largest maximum injection collector bus for the REZ occurred at the Mead 500-kV substation and was 3,981MW. The total injection at the 10 REZ collector buses was 42,212MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3919
	19038	Mead	500	14	191	3981
2	19022	Davis	230	14	191	931
3	25405	Iron Mtn.	230	24	248	516
4	19042	Parker	230	14	191	3066
	19910	Parker	500	14	191	3782
5	24900	Colorado River	500	24	800	3606
	19908	Bouse	230	14	191	2516
6	83005	Harcuvar	500	14	191	2381
	19204	Harcuvar	230	14	191	2751
7	83026	CTP 500	500	14	800	3516
8	22536	N. Gila	500	22	227	3607
9	15021	Palo Verde	500	14	910	3778
10	19912	Topock	500	14	191	3862
Total Injection Amount						42212

Table 31 - A2-B4-C3-D2 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A2-B4-C3-D2 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 21,108MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 17,641MW which represents approximately the 42 per cent level and the initial overload for N-1 conditions occurs at 17,406MW of injection which represents approximately the 41 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 2,416MW. This overload occurs at 17,947MW of injection.

A2-B4-C4-D1

Non-Simultaneous Results

The non-simultaneous results for the A2-B4-C4-D1 case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 4,167MW. The total injection at the 10 REZ collector buses was 49,782MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4167
	19038	Mead	500	14	191	4162
2	19913	Davis	500	14	191	3975
	19022	Davis	230	14	191	1340
3	25405	Iron Mtn.	230	24	248	516
4	19042	Parker	230	14	191	2590
	19910	Parker	500	14	191	3795
5	24900	Colorado River	500	24	800	3622
	19909	Mid Point AZ	500	14	191	3691
	19908	Bouse	230	14	191	1968
6	83005	Harcuvar	500	14	191	2517
	19204	Harcuvar	230	14	191	2622
7	83026	CTP 500	500	14	800	3510
8	22536	N. Gila	500	22	227	3622
9	15021	Palo Verde	500	14	910	3777
10	19912	Topock	500	14	191	3908
Total Injection Amount						49782

Table 32 - A2-B4-C4-D1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A2-B4-C4-D1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 40 per cent level. The 40 per cent level represented 19,916MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 16,641MW which represents approximately the 33 per cent level and the initial overload for N-1 conditions occurs at 17,116MW of injection which represents approximately the 34 per cent level. The simultaneous results indicated that at the 40 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 2,168MW. This overload occurs at 17,198MW of injection.

A2-B4-C4-D2

Non-Simultaneous Results

The non-simultaneous results for the A2-B4-C4-D2 case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 4,170MW. The total injection at the 10 REZ collector buses was 49,872MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4170
	19038	Mead	500	14	191	4165
2	19913	Davis	500	14	191	3971
	19022	Davis	230	14	191	1335
3	25405	Iron Mtn.	230	24	248	519
4	19042	Parker	230	14	191	2659
	19910	Parker	500	14	191	3795
5	24900	Colorado River	500	24	800	3615
	19909	Mid Point AZ	500	14	191	3689
	19908	Bouse	230	14	191	1969
6	83005	Harcuvar	500	14	191	2496
	19204	Harcuvar	230	14	191	2644
7	83026	CTP 500	500	14	800	3521
8	22536	N. Gila	500	22	227	3631
9	15021	Palo Verde	500	14	910	3784
10	19912	Topock	500	14	191	3909
Total Injection Amount						49872

Table 33 - A2-B4-C4-D2 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A2-B4-C4-D2 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 40 per cent level. The 40 per cent level represented 19,950MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 16,747MW which represents approximately the 34 per cent level and the initial overload for N-1 conditions occurs at 17,116MW of injection which represents approximately the 34 per cent level. The simultaneous results indicated that at the 40 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 2,199MW. This overload occurs at 17,194MW of injection.

Sensitivity Cases

A1-B4-C3-D1-S1A

Non-Simultaneous Results

The non-simultaneous results for the A1-B4-C3-D1-S1A case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 3,957MW. The total injection at the 10 REZ collector buses was 44,657MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3957
	19038	Mead	500	14	191	3945
2	19022	Davis	230	14	191	970
3	25400	Iron Mtn.	500	24	800	3564
	25405	Iron Mtn.	230	24	248	514
4	19042	Parker	230	14	191	2965
	19910	Parker	500	14	191	3593
5	24900	Colorado River	500	24	800	3428
	19908	Bouse	230	14	191	2485
6	83005	Harcuvar	500	14	191	2446
	19204	Harcuvar	230	14	191	2755
7	83026	CTP 500	500	14	800	3333
8	22536	N. Gila	500	22	227	3425
9	15021	Palo Verde	500	14	910	3569
10	19912	Topock	500	14	191	3708
Total Injection Amount						44657

Table 34 - A1-B4-C3-D1-S1A Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B4-C3-D1-S1A case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 22,331MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 19,483MW which represents approximately the 44 per cent level and the initial overload for N-1 conditions occurs at 19,083MW of injection which represents approximately the 43 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 938MW. This overload occurs at 20,902MW of injection.

A1-B4-C3-D1-S1B

Non-Simultaneous Results

The non-simultaneous results for the A1-B4-C3-D1-S1B case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 3,950MW. The total injection at the 10 REZ collector buses was 44,433MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3950
	19038	Mead	500	14	191	3942
2	19022	Davis	230	14	191	902
3	25400	Iron Mtn.	500	24	800	3601
	25405	Iron Mtn.	230	24	248	572
4	19042	Parker	230	14	191	2846
	19910	Parker	500	14	191	3557
5	24900	Colorado River	500	24	800	3412
	19908	Bouse	230	14	191	2507
6	83005	Harcuvar	500	14	191	2422
	19204	Harcuvar	230	14	191	2776
7	83026	CTP 500	500	14	800	3325
8	22536	N. Gila	500	22	227	3409
9	15021	Palo Verde	500	14	910	3558
10	19912	Topock	500	14	191	3654
Total Injection Amount						44433

Table 35 - A1-B4-C3-D1-S1B Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B4-C3-D1-S1B case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 22,219MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 19,672MW which represents approximately the 44 per cent level and the initial overload for N-1 conditions occurs at 19,208MW of injection which represents approximately the 43 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 538MW. This overload occurs at 21,381MW of injection.

A1-B4-C3-D1-S1B Alt 1

Non-Simultaneous Results

The non-simultaneous results for the A1-B4-C3-D1-S1B Alt 1 case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 3,914MW. The total injection at the 10 REZ collector buses was 44,305MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3914
	19038	Mead	500	14	191	3895
2	19022	Davis	230	14	191	913
3	25400	Iron Mtn.	500	24	800	3590
	25405	Iron Mtn.	230	24	248	573
4	19042	Parker	230	14	191	2776
	19910	Parker	500	14	191	3570
5	24900	Colorado River	500	24	800	3412
	19908	Bouse	230	14	191	2518
6	83005	Harcuvar	500	14	191	2420
	19204	Harcuvar	230	14	191	2784
7	83026	CTP 500	500	14	800	3313
8	22536	N. Gila	500	22	227	3397
9	15021	Palo Verde	500	14	910	3541
10	19912	Topock	500	14	191	3689
Total Injection Amount						44305

Table 36 - A1-B4-C3-D1-S1B Alt 1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B4-C3-D1-S1B Alt 1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 22,156MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 19,816MW which represents approximately the 45 per cent level and the initial overload for N-1 conditions occurs at 19,335MW of injection which represents approximately the 44 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 480MW. This overload occurs at 21,407MW of injection.

A1-B4-C3-D1-S1C

Non-Simultaneous Results

The non-simultaneous results for the A1-B4-C3-D1-S1C case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 3,952MW. The total injection at the 10 REZ collector buses was 44,605MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3952
	19038	Mead	500	14	191	3942
2	19022	Davis	230	14	191	898
3	25400	Iron Mtn.	500	24	800	3551
	25405	Iron Mtn.	230	24	248	571
4	19042	Parker	230	14	191	2934
	19910	Parker	500	14	191	3588
5	24900	Colorado River	500	24	800	3471
	19908	Bouse	230	14	191	2482
6	83005	Harcuvar	500	14	191	2417
	19204	Harcuvar	230	14	191	2749
7	83026	CTP 500	500	14	800	3355
8	22536	N. Gila	500	22	227	3443
9	15021	Palo Verde	500	14	910	3591
10	19912	Topock	500	14	191	3661
Total Injection Amount						44605

Table 37 - A1-B4-C3-D1-S1C Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B4-C3-D1-S1C case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 22,306MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 20,010MW which represents approximately the 45 per cent level and the initial overload for N-1 conditions occurs at 19,565MW of injection which represents approximately the 44 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 287MW. This overload occurs at 21,849MW of injection.

A1-B4-C3-D1-S1C Alt 1

Non-Simultaneous Results

The non-simultaneous results for the A1-B4-C3-D1-S1C Alt 1 case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 3,914MW. The total injection at the 10 REZ collector buses was 44,460MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3914
	19038	Mead	500	14	191	3895
2	19022	Davis	230	14	191	911
3	25400	Iron Mtn.	500	24	800	3546
	25405	Iron Mtn.	230	24	248	573
4	19042	Parker	230	14	191	2857
	19910	Parker	500	14	191	3592
5	24900	Colorado River	500	24	800	3463
	19908	Bouse	230	14	191	2493
6	83005	Harcuvar	500	14	191	2419
	19204	Harcuvar	230	14	191	2756
7	83026	CTP 500	500	14	800	3345
8	22536	N. Gila	500	22	227	3430
9	15021	Palo Verde	500	14	910	3573
10	19912	Topock	500	14	191	3693
Total Injection Amount						44460

Table 38 - A1-B4-C3-D1-S1C Alt 1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B4-C3-D1-S1C Alt 1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 22,233MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 20,074MW which represents approximately the 45 per cent level and the initial overload for N-1 conditions occurs at 19,623MW of injection which represents approximately the 44 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 290MW. This overload occurs at 21,773MW of injection.

A1-B4-C4-D1-S1A

Non-Simultaneous Results

The non-simultaneous results for the A1-B4-C4-D1-S1A case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 4,087MW. The total injection at the 10 REZ collector buses was 45,519MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4087
	19038	Mead	500	14	191	4082
2	19022	Davis	230	14	191	1319
3	25400	Iron Mtn.	500	24	800	3681
	25405	Iron Mtn.	230	24	248	575
4	19042	Parker	230	14	191	2596
	19910	Parker	500	14	191	3740
5	24900	Colorado River	500	24	800	3608
	19908	Bouse	230	14	191	1961
6	83005	Harcuvar	500	14	191	2538
	19204	Harcuvar	230	14	191	2676
7	83026	CTP 500	500	14	800	3499
8	22536	N. Gila	500	22	227	3598
9	15021	Palo Verde	500	14	910	3755
10	19912	Topock	500	14	191	3804
Total Injection Amount						45519

Table 39 - A1-B4-C4-D1-S1A Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B4-C4-D1-S1A case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 22,760MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 19,210MW which represents approximately the 42 per cent level and the initial overload for N-1 conditions occurs at 18,952MW of injection which represents approximately the 42 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 840MW. This overload occurs at 21,446MW of injection.

A1-B4-C4-D1-S1B

Non-Simultaneous Results

The non-simultaneous results for the A1-B4-C4-D1-S1B case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 4,098MW. The total injection at the 10 REZ collector buses was 45,307MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4098
	19038	Mead	500	14	191	4095
2	19022	Davis	230	14	191	1275
3	25400	Iron Mtn.	500	24	800	3667
	25405	Iron Mtn.	230	24	248	577
4	19042	Parker	230	14	191	2493
	19910	Parker	500	14	191	3729
5	24900	Colorado River	500	24	800	3603
	19908	Bouse	230	14	191	1960
6	83005	Harcuvar	500	14	191	2503
	19204	Harcuvar	230	14	191	2683
7	83026	CTP 500	500	14	800	3496
8	22536	N. Gila	500	22	227	3595
9	15021	Palo Verde	500	14	910	3750
10	19912	Topock	500	14	191	3783
Total Injection Amount						45307

Table 40 - A1-B4-C4-D1-S1B Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B4-C4-D1-S1B case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 22,656MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 19,445MW which represents approximately the 43 per cent level and the initial overload for N-1 conditions occurs at 19,097MW of injection which represents approximately the 42 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 484MW. This overload occurs at 21,884MW of injection.

A1-B4-C4-D1-S1B Alt 1

Non-Simultaneous Results

The non-simultaneous results for the A1-B4-C4-D1-S1B Alt 1 case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 3,926MW. The total injection at the 10 REZ collector buses was 44,043MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3926
	19038	Mead	500	14	191	3923
2	19022	Davis	230	14	191	1298
3	25400	Iron Mtn.	500	24	800	3596
	25405	Iron Mtn.	230	24	248	579
4	19042	Parker	230	14	191	2438
	19910	Parker	500	14	191	3594
5	24900	Colorado River	500	24	800	3461
	19908	Bouse	230	14	191	1959
6	83005	Harcuvar	500	14	191	2502
	19204	Harcuvar	230	14	191	2689
7	83026	CTP 500	500	14	800	3360
8	22536	N. Gila	500	22	227	3445
9	15021	Palo Verde	500	14	910	3587
10	19912	Topock	500	14	191	3686
Total Injection Amount						44043

Table 41 - A1-B4-C4-D1-S1B Alt 1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B4-C4-D1-S1B Alt 1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 22,016MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 19,346MW which represents approximately the 44 per cent level and the initial overload for N-1 conditions occurs at 19,009MW of injection which represents approximately the 43 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 338MW. This overload occurs at 21,487MW of injection.

A1-B4-C4-D1-S1C

Non-Simultaneous Results

The non-simultaneous results for the A1-B4-C4-D1-S1C case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 4,107MW. The total injection at the 10 REZ collector buses was 45,390MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	4107
	19038	Mead	500	14	191	4093
2	19022	Davis	230	14	191	1269
3	25400	Iron Mtn.	500	24	800	3651
	25405	Iron Mtn.	230	24	248	576
4	19042	Parker	230	14	191	2538
	19910	Parker	500	14	191	3738
5	24900	Colorado River	500	24	800	3629
	19908	Bouse	230	14	191	1967
6	83005	Harcuvar	500	14	191	2502
	19204	Harcuvar	230	14	191	2637
7	83026	CTP 500	500	14	800	3512
8	22536	N. Gila	500	22	227	3613
9	15021	Palo Verde	500	14	910	3767
10	19912	Topock	500	14	191	3791
Total Injection Amount						45390

Table 42 - A1-B4-C4-D1-S1C Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B4-C4-D1-S1C case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 22,697MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 19,761MW which represents approximately the 44 per cent level and the initial overload for N-1 conditions occurs at 19,418MW of injection which represents approximately the 43 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 232MW. This overload occurs at 22,320MW of injection.

A1-B4-C4-D1-S1C Alt 1

Non-Simultaneous Results

The non-simultaneous results for the A1-B4-C4-D1-S1C Alt 1 case indicated that the largest maximum injection collector bus for the REZ occurred at the El Dorado 500-kV substation and was 3,932MW. The total injection at the 10 REZ collector buses was 44,150MW. The non-simultaneous injections indicated no overloads on the WECC Paths that were monitored.

REZ	Injection Bus Number	Name	kV	Area	Zone	Max Injection Amount
1	24042	Eldorado	500	24	240	3932
	19038	Mead	500	14	191	3910
2	19022	Davis	230	14	191	1297
3	25400	Iron Mtn.	500	24	800	3565
	25405	Iron Mtn.	230	24	248	578
4	19042	Parker	230	14	191	2479
	19910	Parker	500	14	191	3612
5	24900	Colorado River	500	24	800	3504
	19908	Bouse	230	14	191	1965
6	83005	Harcuvar	500	14	191	2504
	19204	Harcuvar	230	14	191	2648
7	83026	CTP 500	500	14	800	3382
8	22536	N. Gila	500	22	227	3474
9	15021	Palo Verde	500	14	910	3606
10	19912	Topock	500	14	191	3694
Total Injection Amount						44150

Table 43 - A1-B4-C4-D1-S1C Alt 1 Case Maximum REZ Injections

Simultaneous Results

The simultaneous results for the A1-B4-C4-D1-S1C Alt 1 case indicated that the overloads began to occur on transmission lines in the study area when tested at the 50 per cent level. The 50 per cent level represented 22,078MW of injection within the 10 REZ. The first limiting element within the study area is the Imperial Valley – N. Gila 500-kV transmission line. The initial overload for N-0 conditions occurs at 19,586MW which represents approximately the 44 per cent level and the initial overload for N-1 conditions occurs at 19,260MW of injection which represents approximately the 44 per cent level. The simultaneous results indicated that at the 50 per cent level one WECC path was overloaded. Path 46, West of River, was overloaded by 163MW. This overload occurs at 21,819MW of injection.

CONCLUSIONS

- The PSLF verification process concluded that all injections amounts showed accuracies of greater than 90 per cent.
- The Post SMRT Project cases indicated an incremental increase in the range of 8,000 – 9,500MW of simultaneous injection capability within the study area. Based on the PSLF verification process results, the incremental increase would be accurate within 10 percent of a study conducted using PSLF as the analysis tool.
- The Las Vegas to Los Angeles Double Circuit 500-kV sensitivity cases indicated an incremental increase (compared to the Post SMRT Project cases) in the range of 1,500 – 3,000MW of simultaneous injection capability within the study area.
- The existing N. Gila– Imperial Valley 500-kV line was the first transmission branch within the SMRT study system to exceed its ratings in each of the 28 Post SMRT Project cases and in each of the 10 Sensitivity Cases; and, within the accuracies of the study's methodology, equally limited the maximum simultaneous Renewable Energy Zone (REZ) injections under either N-0 or N-1 conditions.
- The indicated increase in simultaneous injection capability for the 28 variations of Post SMRT Project cases were within 10 per cent of each other.
- Injection points for REZ 1 (Eldorado, Mead), for REZ 4 (Parker), and for REZ 5 (Bouse, Colorado River, Mid Point AZ) consistently showed the highest Post SMRT non-simultaneous injection capabilities.
- Of the 12 WECC Rated Paths monitored, only Path 46 (West of River) showed potential overload issues.
- Injections at the Palo Verde Hub indicated that approximately 67 per cent of the injection flowed west along the East of River WECC path (Path 49) under non-simultaneous conditions but does not result in an overload condition.

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